Popular Astronomy.

Vol. XXXV, No. 7 AUGUST-SEPTEMBER, 1927 Whole No. 347

PHOTOGRAPHING JUPITER.

By LATIMER J. WILSON.

Jupiter, the bright planet easily photographed through large telescopes, can also be photographed with small reflectors. But with this equipment there are obstacles difficult to overcome. With an eleven-inch reflector of 96 inches focal length the focal image of Jupiter varies between 1/48th and nearly 1/60th of an inch in size. That is indeed a small object to photograph, and without a means of direct enlargement of the image on the plate would be useless for enlargement of the plate by the ordinary process. The details of such a small image are smaller than the grains of the emulsion.

A single negative lens, (double concave —13 diopters), was placed between the flat mirror and photographic plate at such a distance from the latter that an image of about one-twentieth of an inch was formed. On exceptionally clear nights an image of about one-sixteenth of an inch could be used for the short exposures necessary to avoid the motion of Jupiter across the field of view. These images can be enlarged to various sizes up to about three-quarters of an inch in diameter and show the more conspicuous details on the planet. Exposures were made with an old-style portrait-lens shutter, a rubber band being placed across the plunger to hasten the closing of the shutter during bulb exposures. The exposures tested with the shutter of a graflex camera, approximate a tenth of a second. In less transparent atmosphere exposures of about one-sixth of a second were employed. It was necessary to use a fast plate, and ordinary fast emulsions produce graininess in the image. Hammer's Ultra Rapid Press Plates were found the best for this purpose.

DESCRIPTION OF PHOTOGRAPHS (PLATE XI).

1st row: September 5, (1926), $4^h\,30^m$, G.C.T. Longitude for system I, 189°.0; system II, 26°.9. The red spot (center about 23°) is indicated by a slight darkening in the southern part of the south tropical zone in the vicinity of the central meridian. Visually it possessed a pinkish tint.

2nd row and 3rd row: August 5, $4^h\,16^m$, G.C.T. Longitude for system I, 322°.6; for system II, 36°.6. Here the red spot is also near the central meridian but is less distinctly indicated. It was variable in intensity during the 1926 apparition of Jupiter, being at times invisible.

4th row: August 29, $5^h\,0^m$, G.C.T. Longitude for system I, 182°.1; for system II, 73°.0. Near the left edge of the disk can be seen the red spot as rotation carries it toward the eastern limb.

5th row: August 29, $7^h\,20^m$, G.C.T. Longitude for system I, 264°.4; for system II,

84°.6. The shadow of the third satellite is immersed in the dusky tint of the south equatorial belt near the right edge of the disk.

6th row: September 4, $5^h\ 50^m$, G.C.T. Longitude for system I, 80°.3; system II, 285°.5. The red spot should be seen on the eastern (left) limb of the disk but does not appear in the photographs, nor was it noted visually.

On September 5, the red spot was central at 22°.9, while on July 21, $6^h\ 40^m$, G.C.T., it was in longitude 27°.9. This gives a rotation period of $9^h\ 55^m\ 35^s.252$ for that interval. On November 7, $8^h\ 36^m$, an obscuring dusky tint seemed to spread over the south tropical zone. Photographs taken at $1^h\ 33^m$ (system II, 24°.6) faintly show the following end of what seems to be the red spot, approaching the central meridian and measured about ten degrees from it. Reduction for longitude of the center of the spot furnishes 20°.1, system II, probable error 2° ±.

Spots in the northern equatorial belt have been ephemeral, but there has been one more lasting marking, a deep gash slanting into the equatorial zone from a dark spot in the north equatorial belt. Spots and rifts in the belts and zones seem to assume an evenly spaced arrangement around Jupiter, and there have been a number of these markings which could only be identified by continuous observation. The marking referred to is shown in the drawing of Jupiter in POPULAR ASTRONOMY for October, 1926. The preceding dark rift in the equatorial zone seems to have been identified on October 28, $1^h\ 5^m$, system I, 151°.9. It was in longitude 207°.1 on July 21. This gives a rotation for the currents of the equatorial zone somewhat more rapid than that assigned in the chart published in "Splendour of the Heavens." (Vol. I, page 342.) While the rotation for the currents of the equatorial zone is given as $9^h\ 50^m\ 26^s$, the rotation of this dark rift seems to be $9^h\ 50^m\ 7^s.808$. However, as there were several of these rifts distributed around Jupiter there may have been a mistake in identification.

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RECENT ADVANCEMENT IN ASTRONOMICAL THEORY.*

By J. D. BOON.

It seems in harmony with the properties of this occasion that marks the close of the first quadrennium of this Society as a chartered scientific body, that we should direct our thoughts for a short time to the progress that has been made in recent years, in our chosen field of study. While it has not been our privilege to contribute, to any measurable extent, to this progress, it is our privilege to understand the progress that is being made, and to rejoice in the fact that man is beginning to understand something of the worlds that lie about him.

*Paper presented at the meeting of the Dallas Astronomical Society, April 23, 1926.

A few years ago it was commonly thought that the stars vary very widely, not only in volume and brightness, but in mass also; that our sun was a very small sun, as suns go, both in mass and in size. Recent investigations have proven that this notion is partly in error; that while suns do vary in size, they are all of approximately the same mass. The giant suns, such as Betelgeuse and Antares, are just as remarkable for their low density as for their gigantic volume. In other words, the large suns are composed of highly expanded gases. That the stars are of approximately the same mass is a very remarkable fact. One is led to wonder if there is some factor or unit operating in nature that determines the amount of material required to form a star. Eddington has stated that the factors are to be found in the application of the gas laws, under conditions of temperature and pressure and light pressure that cannot be duplicated in our laboratories. Whatever the explanation may be, it is doubtless true that there is some natural method of selecting the amount of material that goes into the making of a star.

On looking at the stars through a clear atmosphere, it will be noted that they vary rather widely in color. Some are blue-white, others are white, and still others are yellow, or even red. Naturally, one would think that the colors are indicative of age, that the blue-white stars are the youngest, and that the red stars are much older and have had time to cool. However, it has often been pointed out that this order does not fit all of the facts; that there are many reasons for thinking that the real order is just the reverse of that which has been mentioned; that as a star grows older it grows brighter.

Fifty years ago Lane proved that if a large body of gas radiates heat and contracts, the contraction will produce more heat than can be radiated, and the body of gas will grow higher in temperature as time goes on. This statement seems paradoxical, but it is doubtless true. Taking into consideration Lane's law and the spectra, Russell has worked out the chronological order of the stars in a very satisfactory way. His order is as follows: All stars begin as giant reds of very low density. As time goes on they contact and rise in temperature until they reach the blue-white stage. At this point contraction largely ceases, and the loss of heat begins to exceed the gain, and the star falls in temperature, going through all of the color stages again until it finally becomes a dwarf red, after which stage it disappears as a dark sun of small volume and high density. So runs the life history of a star.

In the southern hemisphere, near the south pole of the sky, may be seen two great clouds of stars. These stars were first described by Magellan, and hence they are known as the Magellanic clouds. The lesser of these clouds has been the object of very careful study for a number of years, and it is known to contain samples of all the different kinds of bodies found in the Milky Way. In the study of this cloud special attention has been given to the Delta Cephei variables. Delta

Cephei variable stars are found throughout the Milky Way, and are of great interest because of their periodic variations in the amount of light that they emit.

About twenty years ago, Miss Leavitt of the Harvard Observatory made a remarkable discovery while she was going over the photographs of the lesser Magellanic cloud. She found that there is a direct relation between the luminosity of the Delta Cepheids in this cloud, and their period of pulsation; that the large and brilliant stars pulsate slowly, requiring forty or fifty days to complete the cycle, while the small variables undergo a much more rapid change. Since this discovery by Miss Leavitt, Shapley has found that this same relation of period of fluctuation to luminosity holds for all Delta Cepheids, no matter where they may be found; and he has been able to assign a definite magnitude to variables of any definite period of pulsation. These discoveries have been of very great value in measuring stellar distances. The old parallax method of measuring distances by the displacement of the stars as the earth goes around the sun can be used for nearby stars only. In the Delta Cephei stars, the astronomer has a new yard stick, by means of which the distance to any star cloud or cluster may be measured, provided the cloud or cluster contains variables that can be made visible with the telescopes that are at hand. The principle involved in this measurement is very simple. Since an observation gives both the actual and the apparent magnitude of the star, its distance may be readily calculated.

Using this method of measuring distances, Shapley has calculated the dimensions of the Milky Way. His results are startling. We had come to think of the Milky Way as a disk-shaped cloud of stars, with a diameter of a few thousand light years and a thickness one-tenth as great, and that the sun was somewhere near the center of the disk. Shapley found the disk to be not less than 300,000 light years in diameter and its thickness about one-twentieth as great. He has estimated that the center of the Milky Way is in the direction of the Constellation of Sagittarius, and at a distance of 60,000 light years. So this is our location in the stellar universe: We are 60,000 light years from the center of a star cloud that is 300,000 light years in diameter. A light year, you remember, is the distance that light travels in one year of time, going at the rate of 186,000 miles per second. How many stars are there in this cloud? No definite answer to this question can be given, but doubtless the numbers are to be reckoned in terms of billions. Such a system, it seems, would contain the whole stellar universe. But does it?

Far out toward the poles of the Milky Way there are tens of thousands of thin disk-shaped bodies that resemble, very much, revolving fire-wheels. These are the Spiral Nebulae. For many years these strange wheels of light, with their spiral arms, have fascinated and puzzled the astronomer. Some have thought that they were compara-

tively nearby bodies of gas. Others have maintained that they were far away galaxies of suns, and they have called them "Island Universes." Recently Hubble, using the great telescope on Mt. Wilson, has resolved the spiral nebula in the constellation of Andromeda into myriads of separate suns, and among these he has found Delta Cephei variables. By means of these variables he has measured the distance to this spiral and found it to be approximately one million light years away, and it is also comparable in size to the Milky Way. This proves the Island Universe theory, and enlarges our conception of the stellar universe by an inconceivable amount. Since Hubble's discovery, the idea that the Milky Way is a Spiral Nebulae has been greatly substantiated. Campbell in a recent address made the following statement: "We do not know, I must confess, that our stellar system is a spiral nebula, or that it is a developed product of a spiral of ages past, but it does seem to have most of the known attributes of a spiral." If this be true, then our Milky Way, along with the other spirals, may be thought of today as one of the major cosmic units.

I have mentioned a few of the many lines along which progress has been made. Other lines of progress will occur to those who are familiar with modern astronomical science. One fact has grown clearer with each advance that has been made; and that is the dependence of each of the various branches of science, one upon another. It was the knowledge of the solar system that led to a knowledge of the structure of the atom, and in return the structure of the atom, through the spectroscope, is revealing the structure of the stellar systems. The threads that bind all things together are so intricately and intimately interwoven, that if but one strand be followed throughout its various ramifications, it will lead to every other strand in the material universe.

It is a long journey that man has made from the small flat earth with its nightly candles hanging from the inner surface of a revolving dome to the gigantic universe with its countless millions of systems, from which suns are born like sparks from a revolving fire-wheel. The success that has been attained leads to the belief that all problems may, in the long run of time, be solved; that there is a principle of correspondence between the mind of man within, and the things that lie without, such that truth may be found, no matter where it may be.

Great as has been the progress of late years, there still remain many old questions that cannot be answered. In trying to answer these questions, we are made to wonder if there still remain principles just as fundamental as those discovered by Newton, that are as yet unknown. Einstein's theory is an effort to grasp things that are dimly seen.

In conclusion I wish to mention a few questions that cannot be answered:

We have no adequate theory as to the source of the heat of the sun and stars.

We cannot tell why the moon has come so to move that it keeps the same face turned toward the earth.

We may know something about the life of a star, but we "cannot tell from whence it cometh nor whither it goeth."

We may know that the Delta Cephei stars pulsate in a given way, but we cannot tell why.

We have no satisfactory explanation of the Novae, those strange bodies that flash up into brilliant stars for a short time, and then go out, having "given their souls for one crowded hour of glorious existence."

But it is futile for one to try to mention all of the unsolved astronomical problems. Each new discovery enlarges the circle of contact of the known and the unknown.

Southern Methodist University, Dallas, Texas.
April 20, 1926.

ISAAC NEWTON AND HIS WORK IN ASTRONOMY AND OPTICS.

By RALPH H. CURTISS.

[*Continued from page 313.*]

Before Newton wrote the *Principia* he had formulated the law of gravitation as applying to the attraction of the earth for the moon and of the sun for the planets. But according to the third law of motion, gravitation appeared no longer as a property peculiar to the central body of a system but to the planet or moon as well. Moreover the fact that separate bodies on the earth are attracted by the earth, and therefore in turn attract it, suggested that the attraction of a celestial body is the sum of the attraction of all its constituent particles. Thus we reach the general statement of the law of gravitation as follows: "Every particle of matter attracts every other particle with a force proportional to the product of their masses and inversely proportional to the square of the distance between them." This is essentially the statement of the law that may be formulated from Proposition VII, Book III, of the *Principia*.

One further point needed to be established before this law could safely be applied to the heavenly bodies. In all of the astronomical problems so far considered the attractions between celestial bodies had been regarded by Newton as if they were accurately directed toward their centers, and the distance between these centers had been taken as the distance between the bodies. Newton questioned this assumption

during his early studies of the action of gravitation but early in 1685 he succeeded in justifying it. By an ingenious demonstration he showed in Book I of the *Principia* that if a body is spherical in form and equally dense throughout, it attracts any external particle exactly as if its whole mass were concentrated at its center. He derived the same result for a non-homogeneous sphere made up of concentric spherical shells each of uniform density throughout. Thus he was ready to apply his laws to the celestial bodies as we find them, taking their centers as the centers of attractive force.

When the law of gravitation was thus provisionally established, the great task which confronted Newton, and to which he devoted much of the first and third books of the *Principia*, was that of deducing from this law and the laws of motion the movements of the various members of the solar system, and of showing that the movements so derived were in harmony with observation. If this were successfully done, it would afford a most convincing verification of the rigorous character of Newton's laws.

But Newton encountered very serious difficulties when he came to the actual calculation of lunar, planetary, and cometary motions. If, for example, in dealing with Saturn he could have dealt exclusively with the sun's attraction the orbital motion would have been deduced easily on the basis of his studies of 1670, dealing with the relatively simple problem of the motion of two mutually attracting bodies. But the attraction of the other planets, notably Jupiter, had to be taken into account. And although such planetary attraction could be regarded as producing small disturbances or perturbations from the true orbit, the problem of planetary motion even in this simplified form was never solved by Newton in more than a preliminary way. Yet he was able to point out certain general results which must arise from the mutual attraction of the planets. Of these the most interesting was the slow forward motion of the major axis of the earth's orbit, which had long before been observed by astronomers. He pointed out also that Jupiter, by virtue of its great mass, must produce a considerable effect upon the motion of its neighbor Saturn. Thus he furnished some explanation of a perturbation first noted by Horrocks in the motion of Saturn.

Newton was especially interested in the motion of the moon and though the problem of the lunar theory presented especial difficulties, he succeeded in overcoming them much more completely than those connected with the planets. In the case of the moon the enormous mass of the sun, even at its greater distance, disturbs quite sensibly the normal lunar orbit about the earth. Irregularities, which already had been observed, were explained by Newton as due to the sun's attraction and in the case of the large motion of the moon's nodes and of her apogee he was able to arrive at a fairly accurate numerical result. Further he discovered a number of other irregularities which had not been noticed and indicated the existence of analogous irregularities in the motions of

satellites of Saturn and Jupiter.

Newton explained in the *Principia* the principal librations of the moon, in longitude and latitude, pointing out that it was on letters from himself that the explanation published by Mercator in 1676 had been based. Since the moon revolves about the earth and rotates about its own axis in the same period and in the same direction and its axis is not far from the normal to its orbital plane, it presents to the earth ap-

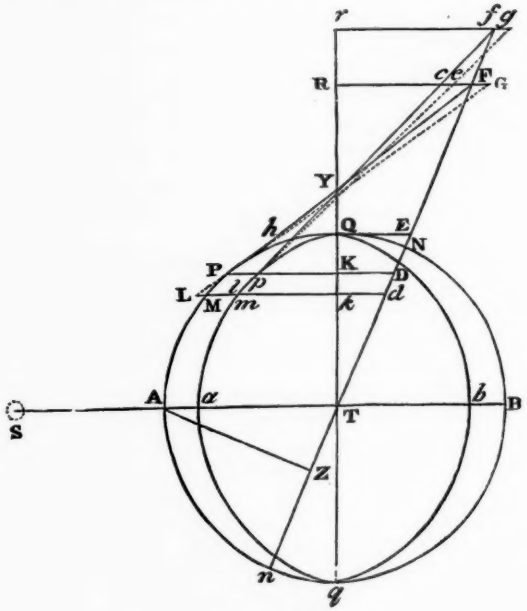


FIGURE 3.
NEWTON'S FIGURE USED IN FINDING THE HORARY MOTION OF THE NODES OF THE MOON.

proximately the same face at all times. The lunar librations are apparent tippings or deflections of the moon's face as viewed from the earth by reason of which we see slightly different parts of her visage. The longitudinal libration occurs, in Newton's words, because the same face of the moon always respects the center about which the mean motion is performed, that is, the exterior focus of the orbit nearly; hence arises a deflection of the moon's face from the earth, sometimes toward the east, and at other times toward the west; and this deflection is equal to the difference betwixt its mean and true motions; and this is the libration in longitude. But it is likewise affected with a libration in latitude arising from the inclination of the moon's axis to the plane of

the orbit in which the moon is revolved about the earth; for that axis retains the same position to the fixed stars nearly and hence the poles present themselves to our view by turns during each revolution of the moon about the earth.

An important possibility which Newton saw in his theory of gravitation was the estimation of the masses of the planets possessing satellites, and of the mass of the sun, all in terms of the earth's mass. In this way he derived values of the relative masses of Jupiter, Saturn, the earth, and the sun, as reliable as knowledge of distances would permit.

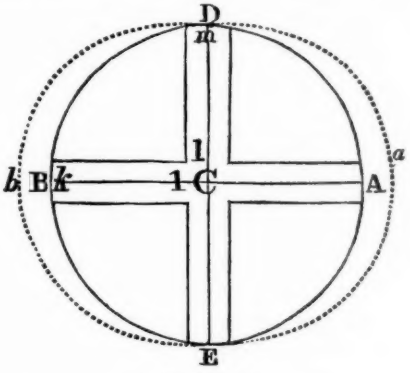


FIGURE 4.
NEWTON'S FIGURE SHOWING RIGHT-ANGLED, CYLINDRIC CANAL PASSING THROUGH THE EARTH'S CENTER.

Newton also pointed out that the oblate form of the earth, which had been indicated by pendulum observations in 1672, was a consequence of the earth's rotation combined with the mutual gravitation of the earth's constituent particles. His solution of this problem is strictly classical and has been quoted perhaps more frequently than any of his elegant processes. He supposed a tube of water to extend from the pole to the center of the earth and thence to a point on the equator. He then found the condition that these two columns of water, under the operation of forces due to gravitation and rotation, should balance. He then supposed that the water in the two connected polar and equatorial columns was frozen hard, pointing out that the height of the two columns would remain unaltered. Apparently he felt that the earth had taken its present shape when in a fluid form. In applying this method he was forced to make certain assumptions respecting the interior of the earth which were not more than rough approximations to the truth. Consequently though he reached the correct conclusion that the earth is flattened at the poles and bulges out at the equator, the actual numerical expression for the terrestrial oblateness was not very accurate, for Newton's result was 1/230 whereas the modern result is 1/293. Newton calculated

in a similar way the oblateness of Jupiter which owing to Jupiter's more rapid rotation is considerably greater than that of the earth. His result was confirmed telescopically by Cassini a few years after the publication of the *Principia*.

From his study of the non-spherical shape of the earth Newton proceeded to an explanation of the precession of the equinoxes, a phenomenon which had been discovered eighteen hundred years before but the cause of which had remained a complete mystery. Newton showed that the attraction of the sun or moon for the equatorial bulge of the earth would produce a gyration of the axis giving rise to an effect of the same general character as precession. He calculated the amount of this precession and arrived at a remarkably good value—accidentally, however, since his knowledge of the quantities involved was quite rough for the purpose. He also pointed out that the axis of the earth, by a motion of nutation or nodding, would librate toward the ecliptic and return again to its former inclination twice in each revolution.

In the *Principia* Newton gave a general explanation of the tides which he accounted for on the basis of the attraction of the sun and moon. According to the law of gravitation this attraction is greater for the waters facing the attracting body than for the earth as a whole, and greater for the earth as a whole than for the waters on the far side. These differences are productive of the tide raising force. Newton pointed out that the more marked or spring tides would occur when the sun, moon, and earth were in line, and that the neap tides would result when sun and moon were pulling at right angles. He showed that the tidal effects varied as the cube of the apparent diameter of the attracting body. He stated also that the effect of either sun or moon depends upon its distance above or below the equator, and upon the latitude of the station as well as accidents of the earth's surface. Newton's theory was by no means complete enough to furnish predictions of the time or height of a tide at any given place but it did give a satisfactory explanation of many of the general characteristics of the tides. And he put his study of the tides to an interesting use in that he employed the observed tidal forces of the sun and of the moon to estimate the mass and density of the latter in terms of the former and thus in terms of the earth's mass and density. His determination of the mass of the moon, though about twice its true value, must be regarded as a notable achievement in view of the difficulties encountered. This error in the mass led Newton to conclude, according to Motte's translation, that "The body of the moon is more dense and more earthly than the earth itself."

Until shortly before Newton's time comets had been regarded as vaporous exhalations from the earth in the higher regions of our atmosphere. Even Tycho, Kepler, and Galileo, although recognizing comets as celestial bodies, were unable to account for their motions. Tycho, by studies of the comet of 1577, was the first to establish their

rank as truly celestial. Kepler supposed that they moved in straight lines and appears to have been more than half disposed to regard them as sentient beings travelling through space with will and purpose. Hevelius, in 1675, was the first to suggest that the orbits might be parabolic and his pupil, Doerfel, proved this to be true for the comet of 1681.

Newton showed that comets are higher than the moon and in the region of the planets. He assumed that comets moved like the planets according to the laws of motion and gravitation. In Book III of the *Principia* he derived on this basis a method of calculating the parabolic path of a comet from three observations. He derived the orbit of the

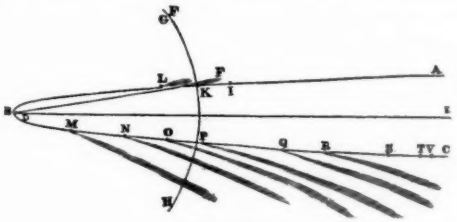


FIGURE 5.
NEWTON'S DRAWING OF THE ORBIT OF THE COMET OF 1681.

comet of 1681 and computed positions of that comet in close agreement with those observed. In the later editions of the *Principia* he investigated the motions of a number of other comets with a similar result. He thus established that in many cases a comet's path is either a parabola or an elongated ellipse, a result which he had anticipated, since he reasoned that comets would be regularly visible and not subject to capricious appearance and disappearance if they moved in nearly circular orbits like those of the planets. This reduction to rule of the complex movements of the comets, and their inclusion with planets in the category of bodies revolving about the sun, may fairly be regarded as one of the most striking of the many discoveries in the *Principia*.

Newton indulged in some conjecture regarding the nature of comets and in particular the structure of their tails. He concluded that comets shone by reflected sunlight and thus were brighter as seen from the earth when nearer the sun, which accounted for the fact that they are so frequently seen in the hemisphere occupied by the sun. He also found it evident that the celestial spaces are void of resistance since the comets move in every direction with the greatest freedom. He was satisfied that the bodies of comets are solid, compact, fixed and durable, like the bodies of the planets, for otherwise under the fierce heat of a close approach to the sun they would be consumed and dissipated. He concluded that comet tails were very fine vapor which the head or

nucleus of the comet emits by its heat. Thus the tail arises from the head and must ascend toward the parts opposite to the sun, as the smoke of the heated body ascends in our air, the impulse of the sun's light promoting the ascent in the case of the comet. Though Newton could and did account for the incurvation of the tail it was of course impossible that he should account fully for its repulsion from the sun.

Another speculation regarding comets that was not entirely fortunate related to the problem of conservation. In Newton's words, it is not unlikely that the vapors, perpetually rarefied and dilated in the tails of comets, may be at last dissipated and scattered through the whole heavens, and little by little be attracted toward the planets, and mixed with their atmospheres. For the conservation of the seas and fluids of the planets, comets seem to be required so that from their exhalations and vapors condensed, the wastes of the planetary fluids, spent upon vegetation and putrefaction and converted into dry earth, may be continually supplied and made up. For all vegetables entirely derive their growths from fluids, and afterwards, in great measure, are turned into dry earth by putrefaction; and a sort of slime is always found to settle at the bottom of putrefied fluids; and thus it is that the bulk of the *solid* earth is continually increased; and the fluids, if they are not supplied from without, must be in a continual decrease and fail at last. Though Newton knew nothing of the escape of atmospheres some features of his speculations are not inappropriate. A further tribute to the value of comets is found in the statement, "I suspect, moreover, that it is chiefly from comets that spirit comes, which is indeed the smaller, but the most subtle and useful part of our air, and so much required to sustain the life of all things with us." Comets may even rekindle the stars or as Newton expresses it, ". . . fixed stars, that have been gradually wasted by the light and vapors emitted from them for a long time, may be recruited by comets that fall upon them; and from this fresh supply of new fuel those old stars, acquiring new splendor, may pass for new stars." It is true today as in Newton's time that although we can predict accurately where a comet is going to be at a given time, we cannot tell what it is going to do.

Newton was the first astronomer to form any true idea of the distances of the stars. The circumstance that their annual parallax was too small to measure, Newton used to establish their great distance. From the theory of gravitation he showed that the stars must be hundreds of times as remote as Saturn, then the most distant planet known, otherwise they would either fall into the sun or describe orbital motion about it. Reasoning from the brightness of Saturn he was led to suppose that the distance from which the sun would shine as a fixed star of the first magnitude would exceed that of Saturn by about 100,000 times. Thus Newton's reasoning, which was as ingenious as it was sound, led to a correct estimate of the order of magnitude of stellar distances. At the distances thus established the stars could not be visi-

ble, like the planets, by reflected light. Therefore they must be self-luminous bodies like the sun and probably comparable with it in brightness, and possibly like it the centers of other planetary systems.

Thus Newton developed his "system of the world" largely "in a mathematical way," and presented it *to* the world in his *Principia*. The cause of the properties of gravitation he left without explanation though by its power he explained the phenomena of the heavens and of the sea. The laws he adopted coördinated the phenomena of mechanics in a striking manner, while their value is witnessed by the brilliant achievements in the physical sciences in the last two centuries as compared to the slow and faltering advances of the ancients. Although these laws are consistent with nearly all the phenomena so far observed, it is natural to wonder whether they are primary and fundamental laws of nature, even as modified by the principle of relativity. The possibility remains that the Newtonian system or this system as modified by Einstein, even though it may not be found to be in error, will be supplanted by another and perhaps a simpler one. However this may be, one major conclusion appears to be inescapable. And this is that we live in a preëminently orderly universe—a universe in which law and order reign supreme. This is the great truth which astronomers have discovered, developed, and are extending rapidly today. We honor Newton because he contributed more than any other individual to the establishment of this fundamental and salutary conclusion.

The *Principia* appears to have been printed in a limited first edition which was exhausted in three or four years. It was read by the leading continental mathematicians and astronomers and was very warmly received in England. But Newton's fundamental principle of attraction between bodies separated by empty space, seemed impossible to those who had not grasped the idea of judging a theory on the basis of its accordance with observed facts. Even Huyghens regarded the idea of gravitation as absurd and expressed surprise that Newton should have taken the trouble to make so many laborious calculations on such a basis. The dispute between Newton and Leibnitz over the invention of the differential method probably contributed to a neglect of Newton's work on the continent. Indeed half a century elapsed before Newton's new theories made any substantial progress there. But in England mathematicians read the *Principia* with admiration while others endeavored to understand Newton's discoveries.

Meanwhile Newton continued his work, especially on the lunar theory, concerning which he once told Halley in despair that it "made his head ache and kept him awake so often that he would think of it no more." Observations of the moon by Flamsteed, Astronomer Royal, were helpful at this time. In 1691 there was talk of a new edition of the *Principia* but a nervous disorder overtook Newton in 1692 and it is by no means certain that he ever recovered his full mental activity and power. However, he resumed preparations for a new edition of

the *Principia,* besides renewing studies on the lunar theory, until 1695 when he began active public life. In 1704 he published his treatise on Optics mentioned above and in 1713 assisted Cotes with the publication of the second edition of the *Principia* in which important improvements and additions were made to the lunar theory and to the discussions of precession and of comets. A third edition of the *Principia,* edited by Pemberton, was published in 1726 but Newton, who was then 84, contributed little that was new and no alterations of great importance were incorporated. This was Newton's last piece of scientific work.

The success of the *Principia* brought Newton into public life transforming the quiet, retiring Cambridge professor into a public character with ever decreasing leisure for scientific pursuits. He was elected to parliament in 1688, the year after the *Principia* was published. He was appointed Warden of the Mint in 1695 and moved to London. Four years later he became Master of the Mint, leaving his professorship at Cambridge in the hands of a deputy. Late in 1701 he was re-elected to Parliament and still later in the same year resigned his professorship at Cambridge. In 1703 he was elected President of the Royal Society, an office which he held for the rest of his life. The honor of knighthood was conferred on Newton in 1705. His death occurred on March 20, 1727.

Although Newton began life at a serious disadvantage physically, he appears to have outgrown this condition and to have enjoyed a healthy existence except for the nervous ailment of his fiftieth year. And that appears to have been occasioned by the loss of a valuable manuscript. Equanimity and temperance did, indeed, preserve Newton singularly free from mental and bodily ailment. His hair was to the last quite thick, though as white as silver. He made no use of spectacles at any time, and lost but one tooth to the day of his death. He was of middle stature, well-knit, and, in the latter part of his life somewhat inclined to be corpulent. He did not marry, though on two occasions he evinced matrimonial aspirations. In London he lived in a style suited to his elevated position. He maintained an establishment of six servants presided over during the last twenty years by his niece. Though generous and charitable almost to a fault Newton left an estate of 32,000 pounds.

Though Newton must have possessed mental powers befitting a genius he attributed his successes not to any extraordinary sagacity, but solely to industry and patient thought. At times he gave himself to periods of the deepest abstraction during which sleep and nourishment were forgotten. But added to his extraordinary powers of penetration and concentration an important element in Newton's success is clearly found in his adherence to truly scientific procedure. The Baconian method which was adopted by Galileo, became Newton's rule of thought. Incisiveness and superior reason guided him in the formulation of hypotheses and the derivation of verifiable consequences. But patience and devotion are evident in his faithful application of the ex-

perimental method. A single instance will illustrate this point. In a letter to Locke Newton writes of looking several times at the sun in a mirror with the result that he was forced to remain in the dark for three days to recover partial use of his eyes and was troubled with after images of the sun for some months following. Though perhaps an extreme case this illustrates the intensity of Newton's devotion to experimental methods and his sacrifice of time and strength in the interest of science.

It is fitting to conclude this memorial with appropriate words of eulogy and praise. In so doing it is not necessary to invent new phrases. Those most competent to speak have expressed the appropriate thoughts too well. To quote Newton's illustrious successor, Lagrange, "Newton was the greatest genius that ever existed, and the most fortunate, for we cannot find more than once a system of the world to establish." And even his personal rival, Leibnitz, concedes that, "Taking mathematics from the beginning of the world to the time when Newton lived, what he had done was much the better half." It is commonly stated that the *Principia* was the greatest work ever written by a single individual. With such eulogies we may compare Newton's generous recognition of his predecessors in the words, "If I have seen further than other men, it is because I have stood on the shoulders of giants" and his modest estimate of himself in the oft quoted apology:

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble, or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

For a final word nothing could be more suitable than the epitaph inscribed on Newton's tomb at the Abbey,

"Mortals congratulate yourselves that so great a man has lived for the honor of the human race."

TWO NEW PIECES OF DEMONSTRATION APPARATUS FOR TEACHERS OF ASTRONOMY.

By H. T. STETSON.

In an earlier number of POPULAR ASTRONOMY (November 1925) Dr. Alter, of the University of Kansas, gave us an excellent representation of a piece of apparatus for demonstrating the effect of obliquity of the ecliptic upon the seasons and the duration of daylight upon the earth. He closed his rather brief account with a somewhat specific request for the description of other devices developed elsewhere.

Believing that two new devices recently evolved here may be of especial interest to many teachers of descriptive astronomy, the descrip-

tion of them may serve as some response to the above suggestion.

To one who has ever taught physics or chemistry and knows the vital part played by demonstration, the need of more material for visualizing astronomy is most keenly felt. If, to the man of the street, "Seeing is believing," then for the student, visualization is fascination.

I. A Device for Demonstrating the Law of Conservation of Moment of Momentum.

The question of the variation in the earth's period of rotation, aside from the matter of tidal friction, calls for a careful consideration of all causes tending to transfer mass toward or away from the earth's axis of rotation, whether by the transportation of silt through rivers

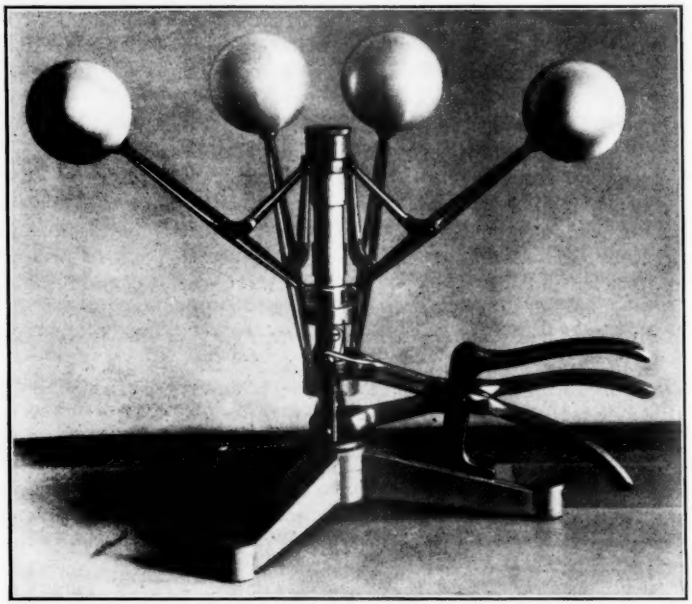


Figure 1.
Apparatus for the Demonstration of Conservation of Angular Momentum. Phantom shows spheres moved to inner position by means of upward movement of lever at the right.

flowing toward or away from the poles or the expansion or contraction of the earth itself. The description of the law of conservation of angular momentum or a dissertation upon $I\omega$ cannot be expected to arouse great enthusiasm in a beginning course in descriptive astronomy. When, however, one can actually show with startling visualization a slowly rotating mass suddenly doubling its speed upon a contraction instigated

PLATE XII

APPARATUS FOR DEMONSTRATING THE PRECESSION OF THE EQUINOXES.

at will by the instructor, physical laws take on a new meaning in astronomy.

The momentum apparatus is illustrated in Figure 1 and consists essentially of two metal spheres mounted much in the fashion of an inverted steam governor but so constructed that while rotating about the vertical axis, their distance from the axis can be altered at the pleasure of the operator. The demonstrator controls the apparatus by the grip of one hand much as in operating a pair of shears. The two spheres are initially set in slow rotation by the hand. The centrifugal force unimpeded will cause the spheres to rotate at maximum distance from the axis. The radius may then be reduced any amount by the grip of the hand upon the two projecting handles. Instantly the spheres are drawn together they will speed up their rotation. As the grip is released, they automatically separate and slow down, to again quicken their speed when once more drawn together by the action of the hand upon the gripping lever. The ball bearings are especially designed to take care of the thrust forces acting upon them and the whole affair will continue to spin through several such demonstrations, always in accordance with the law of the conservation of angular momentum $\Sigma mr^2\omega =$ constant, where ω equals the angular velocity of rotation. Thus the effect of the distribution of mass with respect to the axis on the consequent time of revolution in any rotating system is strikingly portrayed.

Besides the demonstration of the effect of contraction, expansion, and shifting of material of the earth's crust upon the length of the day, many other applications to astronomical phenomena will suggest themselves, such as the effect of contraction of a nebulous mass on the period of revolution of evolving planets; the effect of expansion and contraction in the rotation period of a star or other gaseous body, and especially the correlation between the period and the orbital radius in the case of binary stars.

II. An Apparatus for Demonstrating the Precession of the Equinoxes.

Every teacher of astronomy knows something of the difficulties experienced in trying to convey to a class of beginners the conception of a wobbling earth and the resultant effects on the westward motion of the equinoctial points together with the slow revolution of the north celestial pole about the pole of the ecliptic once every twenty-five thousand years. To help visualize this conception various forms of apparatus have been used by the teacher of astronomy, comprising for the most part gyroscopic tops, interesting in themselves, but of which the relation to earth and sky is at first none too apparent. To improve this visualization suggested by the gyroscopic top a special form of apparatus has been devised the design of which is clearly shown in the accompanying figure (Figure 2).

FIGURE 2.
Apparatus for Demonstrating the Precession of the Equinoxes.

Here an actual terrestrial globe is built about a heavy gyroscopic top which keeps its equilibrium upon a hardened point. The band of metal about the terrestrial equator serves to suggest the equatorial bulge and at the same time affords the mechanical righting force which would

tend to set the earth's axis perpendicular to the plane of its orbit, represented by a plane parallel to the table surface on which the apparatus stands. To make the plane of the ecliptic even more apparent it will be observed that a horizontal metal ring completely surrounds the globe for this purpose. When at rest, the globe will stand in a position of equilibrium with its axis vertical and the equatorial bulge in the plane of the outside ring. If now the axis is displaced from the vertical and then freed, the whole affair will oscillate back and forth like a compound pendulum. The period of oscillation will obviously depend upon the righting force.

A special feature of the apparatus is the placing of an adjustable counter-poise weight inside the globe itself where it may be reached conveniently from below by the hand. As the weight is very easily raised and lowered by a screw adjustment, the centre of gravity of the globe with respect to the point of support may be changed at will, thereby increasing or decreasing the gravitational pull on the self-contained gyroscope. The strength of the righting force can be determined by the period of oscillation when the "earth" is allowed to tilt back and forth in pendulum fashion.

When the axis is displaced from the vertical and the globe placed in rotation as is easily done by the spinning of the knurled knob between the thumb and finger, the rotating earth will at once begin to precess. The period of precession is dependent on the adjustment of the righting force. When the inside weight is adjusted to the lower limit allowed, the righting force is then strongest and the whole revolution of precession takes place about the pole of the ecliptic in a short interval of approximately five seconds. The apparatus may then be stopped, the weight raised to an intermediate position, and when the inclined axis is again set in rotation, it will be observed that the rate of precession is perceptibly slowed down, a complete revolution taking place in a minute or two. If now the weight is moved to its upper position, the globe will be found very nearly in a state of equilibrium, the righting force is very small as may be demonstrated by allowing the globe before spinning to oscillate about its pivot. If now the axis is again set in rotation, the righting force being very small the precession will be exceedingly slow and will take from ten to twenty minutes for a complete revolution.

It is obviously but a little stretch of the imagination for the student to picture that in the case of the actual earth itself, the equatorial excess of matter is so small proportionally that the righting force tending to bring the earth's axis to perpendicularity with the plane of its orbit is so small that twenty-five thousand years are consumed for the pole of rotation to make one complete turn about the pole of the ecliptic.

The apparatus shows not only how the cause of the gyroscopic disturbance of the earth is due to the gravitational pull on the equatorial bulge, but actually visualizes the motion of the line of equinoxes, that is, the motion of the line of intersection of the plane of the earth's

equator with the plane of the ecliptic. This becomes particularly evident because of the added feature of the ecliptic ring whose plane passes through the earth's centre. The student reasons at once from cause to effect and sees the apparent change in the aspect of the terrestrial sphere as a necessary and immediate consequence of the ever-shifting position of the earth's axis of rotation.

Furthermore the extended projection of the earth's axis serves at once for giving the necessary propelling force with the thumb and finger to set the gyroscopic earth in rotation, and at the same time serves as a moving pointer to indicate the direction of the north celestial pole at any moment as the axis precesses in its circular path about the pole at the ecliptic. The pole of the ecliptic itself is indicated by an inverted arrow and designates the perpendicular to the plane of the ecliptic or the plane of the earth's orbit.

The rotating body weighs fourteen pounds, is carefully balanced, and is sufficiently heavy to maintain its spinning for a considerable time, yet is readily set in motion by slowly twirling the knurled knob at the upper end of the extended axis. The rotation must, of course, be counter clockwise if the equinoxes are to precess westward.

As the globe precesses the exhibition of the changing relation of the equator to the ecliptic makes possible the demonstration in which both right ascension and declination change for stars in the neighborhood of the ecliptic as the equinoxes retrograde. It becomes obvious likewise that while the celestial longitude of a star uniformly increases there is no appreciable change in the star's latitude. So far as is known, there has been no attempt heretofore to construct a precessional model where a terrestrial globe houses a smoothly running gyroscope upon which the acting force can be readily adjusted at the will of the operator.

For the excellence of the performance and the appearance of these models, much credit is due to the Eastern Science Supply Company, which has spared no pains in securing their mechanical perfection.

Student's Astronomical Laboratory, Harvard University.

THE INTERNATIONAL ZONE CATALOGUES.

By R. H. TUCKER.

The recent publication by the Observatory at Lund of the observations in the zone 35° to 40° north declination recalls the history of the earliest international scheme of co-operation in meridian astronomy. The Lund Catalogue for 1925 contains the observations of the same stars that were included in the earlier catalogue at the same observatory, with an interval of over forty years between the epochs of observation. It is the first repetition of the earlier scheme that has been made with the meridian circle.

Two zones have been photographed by Dr. Frank Schlesinger, at the Allegheny Observatory, and the places of the stars have been reduced and published. Other zones may be completed in this manner. That would provide a broad basis for the investigation of proper motions of the faint stars, in a period of about half a century.

The aim of the original scheme, inaugurated by the *Astronomische Gesellschaft*, and commonly referred to as the A. G. Zones, was to provide meridian circle places for all stars in the northern hemisphere to the ninth magnitude inclusive. There are very closely one hundred thousand stars in such a list. It was too large an undertaking for any one establishment, and by voluntary agreement the sky was divided into zones, and apportioned among observatories having the proper equipment. This should be understood to mean men as well as instruments.

Individual zones were usually 5° of declination in width, but three zones of 10° were among those actually adopted, and two observatories eventually completed more than one zone. It will make the distribution plain, and representative of the actual contributions, to tabulate the several zones observed, after some failures of execution by observatories not listed below.

NORTHERN ZONES.

Berlin Bab.	+80°	+90°	1886 stars
Kasan	75	80	4281
Berlin	70	75	3461
Christiania	65	70	3949
Hels. Gotha	55	65	14680
Harvard	50	55	8627
Bonn	40	50	18457
Lund	35	40	11446
Leiden	30	35	10239
Cambridge, Eng.	25	30	14464
Berlin	20	25	9208
Berlin	15	20	9789
Leipzig	10	15	9547
Leipzig	5	10	11875
Albany	1	5	8241
Nicolaief	− 2	+ 1	5954

There are sixteen zones, each represented by a published catalogue, in this list. Counting the new observatory at Berlin with the old establishment there are twelve contributors. They are located in Germany with three, Russia with three, United States with two, and Norway, Sweden, Holland and England with one each. The most southern zone is 3° in width, and includes but one degree of northern sky. The Albany zone is 4° wide. The summation is above 146,000, but each zone included an extra strip 10′ wide at each of its borders, and the actual number of stars catalogued in the northern sky is about 133,000. This is equivalent to the total number of stars to a limit of magnitude at nearly 9.2 of the visual scale.

The essential requirement was that all stars of 9.0 and brighter in the

visual *Durchmusterung* of Argelander should be observed. Stars fainter than that limit that had been previously observed with a meridian circle were also recommended for inclusion. This option introduced some variation in the extent of different catalogues. In the Albany zone the stars of 9.1 and 9.2 in Bonn VI were observed, and all stars from other existing catalogues that were fainter than 9.0.

Inspection of the numbers of stars catalogued in the separate zones will indicate the diversity of plans for faint stars. Thus the Cambridge zone has an average of about 2700 stars to a degree of declination; while the average of the adjoining zones on each side is about 1800. This is equivalent to extending the limit of inclusion by about three-tenths of a unit of the visual scale. The Cambridge zone does not include all stars to 9.5, but does include a sufficient number of stars fainter than that grade to make the equivalent summation as given here. This new Lund zone is certainly remarkable for its vigorous and prompt execution. It was begun in November, 1920, and fully completed in five years of active observing. It includes about 25,600 observations of 11,765 zone stars, which is an average of two and one-sixth per star, the requirements being at least two observations of each. There were 330 nights of observation, or about 65 per year, with 96 nights as a maximum. The observations were made in periods of three to four hours a night, broken by intervals of a quarter of an hour. From 10 to 16 fundamental and circumpolar stars were included each night. The places of these were taken from the *Berliner Jahrbuch,* based on the system of AUWERS, as were the places of the fundamental stars of the zones of half a century earlier. Under the direction of Professor Gyllenberg, and with a capable staff of assistants, the work was reduced and published by the end of 1926. The observations of the earlier zone of the same region of sky extended through portions of eight years, though only five years of effective work were included. The interval from beginning to end was sixteen years. The catalogue was printed in 1902, seven years after the completion of the observations. Publication of catalogues sometimes had to await the accumulation of funds for that purpose, in the treasury of the society. There were 717 zones observed in this earlier work, on 335 nights, an average of observing similar to that of the recent work. Several of the earlier catalogues required more than twenty years for the full completion of the observations, and the average period was about twelve years. They were published between 1890 and 1902, with the exception of two of the delayed northern zones which appeared in 1910 and 1915. The average epoch of beginning for fourteen zones was 1873, the earliest having been begun in 1868. The average of the closing years of these fourteen zones was 1887. The Albany zone, in the observations of which I took part, was begun in 1878, having been assigned to the Dudley Observatory after the failure of an observatory in Europe, and was completed in 1882, with about three years of active observing. It was among the

first three published, in 1890, the computations having been promptly carried to completion.

The limit of precision set for the early A. G. Zones was a probable error of 0″.6 in each coördinate of the place of a zone star. The precision of the work exceeded this liberal requirement, and was not much, if any, above that figure for the final position, both coördinates combined. The new Lund catalogue has probable errors of about 0″.3 in each coördinate. The places are of at least double the weight of the old observations which have probable errors of about ±0″.5, exclusive of the large element of uncertainty at the present time which is due to small and undetermined proper motions. The number of stars in the new Lund catalogue is about 350 greater than in the old. But there are four stars in the old which are not included in the new, three of these having been too faint to observe at the later epoch. These were stars of 9.5 in the B. D., a flexible grade which often included stars as faint as tenth magnitude.

The right ascensions of 35 stars between $9^h\ 37^m$ and $10^h\ 4^m$ have been compared with those measured at the Lick Observatory in 1926. These stars are in the list prepared for meridian observation, to give places for the small planet *Eros* during its next close opposition in 1930.

The mean correction to the 1875 Lund is —0ˢ.163, at declination 37°.6, and the average residual from the mean difference is ±0ˢ.065.

The mean correction to the 1925 Lund is —0ˢ.027, with an average residual of ±0ˢ.028. Astronomers who have need of star places for comparisons with comets and asteroids can realize, from these figures, the improvement to be expected in the use of modern meridian observations. The adoption of the mean errors given in the Introduction of the new Lund catalogue would allow ±0ˢ.016 as the probable error of the Lick right ascensions, which is smaller than that computed directly from the individual observations of the whole list of 419 stars. For the relatively small number of stars that occur in the Lund catalogue, the precision is possibly greater than the average, in both. The mean difference from the old catalogue may be due largely to the mean of the proper motions, in an interval of 46 years. But the mean of 0″.04 per year would give 0″.05 for the mean parallactic effect of the motion of the solar system, which is a large figure for stars of average magnitude 8.8. Deducting the respective probable errors of the two authorities from the average residual of the comparison, there would remain ±0ˢ.04 for the average accidental proper motion, or ±0″.010 per year. Such a test could not be considered as valid for individual cases, but has some significance in the discussion of errors of star places in the mass. Approximate proper motions have been computed in the new Lund catalogue. For these 35 stars the mean in right ascension is —0ˢ.0018 = —0″.021, and the average is ±0″.025. The mean in declination is —0″.019 (omitting one exceptional large value) and the average is ±0″.030. Without the use of these computed proper motions

the following corrections to the old catalogue are given by the new one:

$\Delta\alpha$ —0^s.143, average residual ±0^s.070
$\Delta\delta$ —0″.80, average residual ±0″.96.

The application of the computed proper motions for an interval of 43 years diminishes the mean right ascension difference to —0^s.066, and the mean declination difference between the old and new catalogues virtually disappears.

The comparisons of the Lick right ascensions are summed up below for five of the old A. G. catalogues, of mean epoch of observation near 1880, and for seven recent catalogues. The new Lund evidently has as high precision as any of these lists of stars.

A. G. Catalogues.

Zone	Decl.	Mean	Av. Residual	
Bonn	45°.9	—0^s.060	±0^s.101	271 stars
Lund	37.6	—0.163	0.065	35
Leiden	32.2	—0.083	0.082	35
Cambridge	27.3	—0.131	0.103	23
Berlin	22.0	—0.045	0.078	21

Recent Catalogues.

Zone	Decl.	Mean	Av. Residual	
Bonn X	40°.8	0^s.000	±0^s.058	58 stars
Bonn XVI	45.2	—0.005	0.076	24
Abbadia	21.9	—0.017	0.038	20
Green. 1910	28.3	+0.040	0.031	37
Ber. Bab. IV	35.9	+0.011	0.032	50
Ber. Bab. V	43.6	—0.012	0.039	11
New Lund	37.6	—0.027	0.028	35

The Lick Observatory right ascensions have been based upon the same fundamental system as the A. G. Zones. The corrections quoted here, however, do not include the systematic corrections which Dr. Kopff has recently tabulated for the B. J. places. These would increase the mean differences by —0^s.022. All the mean corrections to the old A. G. catalogues have already the minus sign. The Lick observations have been corrected for my magnitude equation, a systematic correction not generally applied to the old catalogues. The mean of this correction at magnitude 8.9 is —0^s.037, at 0^s.008 per unit of the magnitude scale. Corrections for magnitude equation have been applied to the right ascensions of the new Lund catalogue. The average of my estimated magnitudes is 8.9 for these 35 stars, while the new Lund average is 8.8.

A series of zones in the southern sky, extending the area which has been completed north of the equator, has also been observed, on the same plan, and under the auspices of the same International Astronomical Society. Five observatories took part, two of them in this country. The observations were made in the period 1888 to 1905, with an average of eleven years for each zone. Four of these southern A. G. catalogues had been published by 1912. That of Algiers had to wait un-

til 1926, and was then printed at the expense of the observatory itself.* The *Durchmusterung* of Schönfeld served as the basis for this series. As he had observed with Argelander he probably carried the same magnitude scale forward very closely up to ninth magnitude; and up to the mutual limit at 9.4 the individual types of Schönfeld are less than 0.1 brighter than those of Argelander. The denser atmosphere, at larger zenith distances, may have made the estimates of the former very slightly too faint in the southern sky.

SOUTHERN A. G. ZONES.

Strasburg	— 2°	— 6°	8204 stars
Vienna Ott.	6	10	8468
Harvard	10	14	8337
Washington	14	18	8824
Algiers	18	23	9997

EXTENSIONS.

Cordoba	—22	—27	15975
Cordoba	27	32	15200
La Plata	52	57	7442
La Plata	57	62	.....
La Plata	62	67	4412

There are over 43,000 entries in the A. G. Zones in this region of 21 degrees, but the repetition of stars in the 10′ strips at each border gives but slightly over 40,000 individual stars. The count for the similar 21 degrees north of the equator gives 40,000, and the two areas have accordingly the same limits of magnitude, equivalent to the count at 9.2 of the visual scale, but only absolutely complete to 9.0.

The Observatory at Cordoba, under the direction of the late Dr. J. M. Thome, completed the observation of two zones of 5° each, beginning at 22° south declination. These were entirely reduced, and ready for the press at the time of his death in 1908. There are about 29,000 stars in the two catalogues, and the comparison with the similar area in the northern sky shows that the limit of inclusion is equivalent to the summation of the stars to 9.5 of Argelander's scale, or 0.3 below that of the northern catalogues. The basis for these Cordoba zones was the Cordoba *Durchmusterung*, which was observed in nearly equal shares by Dr. Thome and myself. There is little doubt that our 9.0 type was closely the same as 9.2 of the northern area. We started the work in 1885 with extensive comparisons with the northern catalogue, but, perhaps due to absorption at relatively large zenith distances in the comparison areas, our ninth magnitude included stars somewhat fainter.

The Cordoba zones were observed with a different system of fundamental stars from that of the northern zones, since the B. J. list did not provide the requisite stars for that area of sky. But it is most

*The new Lund Catalogue has been issued by the Observatory, apparently without aid from the International Society.

useful to the astronomers of today to have the sky completed with meridian circle observations, from the north pole to 32° south. As will be seen in the table above, the Observatory at La Plata, near Buenos Aires, has observed three zones of 5° in width, beginning at 52° south, and two of these have been published. Their foundation is the Cape Photographic *Durchmusterung*, the magnitudes of which were based upon those of the zone catalogue of Dr. B. A. Gould at Cordoba. Comparison of counts of stars per square degree indicates that the type 9.0 of the Cape corresponds closely to 9.1 of Argelander. The count of stars in the two La Plata zones is about 11,000, while the similar area in the northern sky gives about 13,000. The essential requirement of all these zones, the inclusion of all stars to 9.0 of the visual scale, has undoubtedly been fulfilled.

Palo Alto, May, 1927.

A TURRET REFLECTOR.

By PERCIVAL R. ALLEN.

One of the great drawbacks that probably has cooled the ardor of many a would-be astronomer is the low temperature at which he must make observations.

Finding that my brain as well as my body became benumbed by long exposure to the cold of the observatory in the winter time, I cast about for some method of observing while protected from the cold breezes. This difficulty has been overcome by a number of astronomers. Ex-Governor Hartness of Vermont did this successfully by mounting a ten-inch refractor on a revolving ring which formed part of the housing of the observatory. Another method of observing in a comfortable condition and position is by using the Polar Telescope like that at Harvard Observatory. Then, too, Mr. Russell Porter has designed several forms of telescopes which make stellar observations less of a task and more of a pleasure. Others have also attacked this problem.

In every one of the above mentioned forms of telescopes one or more auxiliary mirrors are required, usually expensive flat mirrors. The Hartness Turret Refractor requires a large refracting telescope tube complete and a prism to reflect the stellar image to the observer who is comfortably seated inside the observatory. The thought came to the writer that the Newtonian telescope could be similarly utilized and with no more additional mirrors than would be used in any Newtonian.

Herewith are shown photographs and a diagram of my Turret Telescope as it appears mounted on my house. It is not a very handsome object but is practical for amateur observation. It will be seen in

Figure 1 that the small mirror, S, cuts the cone of rays formed by the large mirror, M, and reflects them down the declination axis, which is hollow, to the eyepiece at E. The observer stands inside the tower and observes through the eyepiece. The mirror, S, is a little larger than usual. In my instrument it is made of plate glass one inch thick, being ground to the proper elliptical form. It is of course silvered on the front surface. Right ascension settings are obtained by the ring, R,

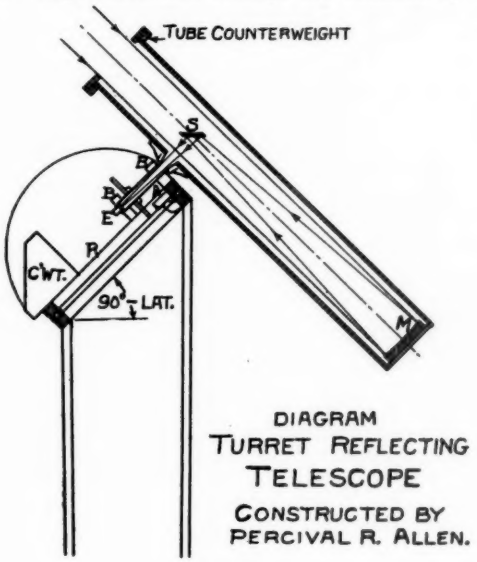


FIGURE 1.

carrying the complete telescope tube in the bearings, B-B, and rolling around on the balls contained in a large race retainer between the two rings. This race retainer has 16 ½-inch steel balls. The machined surfaces of the cast iron rings which bear on the balls are flat. The upper ring is prevented from sliding off the lower one by a pair of radial automobile ball races, A. A handle with rubber pads to press at will against one of these races serves as a vernier in right ascension motion. The vernier for declination motion consists of two wooden bars acting as a clamp on the declination axis when a lever is depressed. Slow motion is imparted to the end of the clamp by a cam. These vernier slow motions are very convenient when seeking a field in variable star work.

The covering over the turret is of rubberized canvas. It is of material similar to that used for automobile tops. A lid on the top of the tube is of the same material and supported by a wire frame. Snow and rain are thus kept out of the turret and the tube.

As is seen in the photograph (Figure 2) the observatory is built

close to a chimney to give stability against vibration. A fireplace, seldom used, feeds into this chimney, so that no detrimental optical effects from heated air are experienced as a rule. The tube swings to either side of the chimney in right ascension so that the latter does not interfere to any extent. Access to the observatory is from below through an opening in the roof. Ladder-like steps are nailed to the inside of the body of the observatory tower. The observer climbs to a height of about six feet from the attic floor of the house, and a small platform is let down to stand on. There is not an abundance of room inside,

FIGURE 2.

FIGURE 3.

but there is enough for manipulation and for a small shelf. A clip hangs the charts on the wall. An Ingersoll watch plays the role of a sidereal clock. Using sidereal time the proper right ascension settings may be had as indicated on a brass ring fastened to the inside of the cast iron ring, R, which is calibrated in hours and minutes. A brass wheel fastened to the declination axis near the eyepiece is calibrated in degrees. Both these are lighted by miniature electric bulbs wired in series to the same switch.

The body of the observatory was constructed by erecting timbers and filling in between with boards cut to shape. The whole was covered with rubberoid roofing and painted (Figure 3). The placement of the heavy rings, which are 2¼x2¼ inches cross section and 28 inches inside diameter, was accomplished by erecting a temporary derrick with block and tackle. The derrick can be set up or taken down in ten minutes or less. Each ring weighs 175 pounds. The counterweights weigh total about 200 pounds, small lead counterweights having recently been added to counterbalance a heavier mirror. The tube counterweight weighs about 45 pounds.

The tube is made of wood lattice work, and covered with cloth painted. Small doors in the side of the tube allow access to the mirrors, which have metal covers removable when the instrument is to be used. A skylight in the roof of the house near the tower makes it easy to get at the tube. Adjustment of the small mirror is obtained by the usual three push and one pull screws at the back of the mirror support. The photograph shows two of the four long rods with handles, used for adjustment of the main mirror at the top of the tower. While lining up the rings to get the right ascension true north, that is parallel to the earth's axis, a finder was temporarily attached to the tube. This had a prism diagonal so that to look alternately through this at some bright star, and then through the regular eyepiece inside the turret, did not require too excruciating contortions of body.

The main mirror for this instrument is paraboloidal and 8 inches in diameter. It was ground by the writer, but being unsatisfactory is being refigured by him. In the meantime I am using a 10½-inch mirror loaned me by Dr. Charles C. Godfrey, who is an expert amateur mirror constructor. I have the glass on hand to make a 10½-inch mirror which will probably have a focal length of 75 inches, as well as 1-inch thick plate glass to make a flatter "flat." Astronomical instruments like radio instruments are always open to improvements.

Now that I have this Turret Telescope I find it difficult to make myself use the old Newtonian down in the back yard observatory where there is limited vision of the sky. When the tube is in the position shown, the observer would have to look up at an angle of about 45 degrees in our latitude near Boston, but this is for stars six hours either east or west of the meridian. Most stars would be very much nearer the meridian and the angle at which one would have to look would be much less than 45 degrees. When observing stars on the meridian, the observer would look horizontally into the eyepiece.

The construction of his own astronomical telescope furnishes one interested in Astronomy an unsurpassed diversion. While all might not have the conveniences of a machine shop as I have had at Wentworth Institute, yet all can construct a more modest instrument of the usual Newtonian type at comparatively small cost.

Should any one wish for more careful explanation of any part of the Turret Reflector, the writer would be pleased to answer any inquiry mailed to him.

131 Rowe Street, Auburndale, Mass.

A VISIT TO ALVAN CLARK, JR.

By REV. JOHN F. SULLIVAN, D. D.

This contribution to the pages of POPULAR ASTRONOMY may be considered as an appendix or supplement to an article in the March number from the pen of Mr. Charles Skeele Palmer, in which he told most graphically and entertainingly of an informal visit to the Clark workshop during the life of the founder of the firm, Alvan Clark, Senior.

I had an experience almost similar to his, in a later year—1893. Mr. Alvan Clark, Jr., was then the head of the famous firm of telescope makers. I had been interested in matters astronomical for a few years, having received some instruction from the well-known Professor George M. Searle at the Catholic University in Washington. Father Searle, now deceased, will be best remembered as one of the first American discoverers of a minor planet, and as the author of a most ingenious plan for reforming the Georgian calendar, which was fully described a few years ago in this magazine in an article by the late Father Rigge, S. J.

Professor Searle, in my University days, had often mentioned his Harvard classmate Alvan Clark; and so, being in Boston on a summer day in '93, I determined to introduce myself to the great lens-maker. My experience in trying to find the Clark factory was precisely like that of Mr. Palmer. Truly, no man is a prophet in his own country. I rode across the bridge into Cambridge, and appealed to the trolley conductor for information. The answer was: "Clark?—never heard of him." Even a letter-carrier, when questioned by the said conductor, stated that he knew of no telescope factory, but "there's a man at the end of this next street who gets a great deal of mail; maybe he's the party." And so I strolled along the next street.

Handsome old-style mansions there were, bordering on the placid Charles, but no sign of a factory. At last, at the end of the quiet street, I beheld a towering iron tube, resembling a smoke-stack—a giant telescope!—the great testing-tube for the Clark lenses.

A ring of a bell, and I was courteously ushered into the library of Alvan Clark, Jr. He entered—a man of beyond middle age, of medium height and sturdy build; with kindly, keen eyes and a neatly trimmed gray beard. I introduced myself as a pupil of his old classmate Professor Searle, and Mr. Clark's eyes twinkled reminiscently. "Searle," he said, "was the best mathematician that ever came out of Harvard. He did fine work in various observatories, and then he joined your Church, and became a Jesuit, or something like that." I told Mr. Clark that his old schoolmate was not a Jesuit, but merely "something like that"—a Paulist, which is an entirely different species of ecclesiastic.

"Would you like to see the factory?" I would. And so we passed out into an orchard, where several old telescopes stood, in various stages of dilapidation and rustiness. Overhead towered the great testing tube, a mighty cylinder of iron, on a lofty brick pier, with a massive equatorial mounting.

I looked for the "factory," and at the end of the grounds we came to a shabby old brick structure resembling a stable—two stories and a basement—the humble birthplace of many of the great lenses of the world, that have penetrated far into the depths and mysteries of space, from Washington, Pulkova, Arequipa, Flagstaff, and the grand observatories that bear the names of Lick and Yerkes.

We entered. Four or five French opticians were there, working without hurry, using apparatus and implements that seemed absurdly simple and inadequate. They were producing marvels of optical art and skill, and they were using no machinery or mechanical device. They were then grinding for Professor Percival Lowell the crown-glass of a 24-inch lens—the wonderful objective which, in the clear air of Arizona, has revealed so many details of the surface of Mars. The operation was simplicity itself. There was a concave iron table, coated with powdered emery and moistened by a small trickle of water. Upon this the glass rested, and four wooden handles had been cemented to it. Two workmen walked leisurely around the table, rotating the disc with a slight forward-and-back movement, causing it to become convex by taking gradually the form of the concavity on which it moved. Later, more delicate abrasives would be used; and the final surfacing and polishing would be done with the bare fingers and a rouge-like paste.

The flint-glass of the Lowell lens, unground, lay near by—a rough octagonal plate, perhaps two inches in thickness and about 28 inches in diameter, with four of its eight edges polished. It was then I had my first view of the perfection of first-class optical glass. Mr. Clark allowed me to look edgewise through it; and the view through that 28-inch block of solid glass was nearly as clear and colorless and transparent as if it were but an inch or two in thickness.

I expressed wonder at the fact that such work was done entirely by hand, and Mr. Clark smilingly answered: "No machine can take the place of intelligent hand-work in things of this kind. We are not manufacturing lenses in quantities."

Then came my introduction to the masterpiece of the genius of the Clarks—the great Yerkes lens. It stood in a corner of the basement, practically finished—a beautiful disc, a mighty circle of clearest glass, 40 inches in aperture, held in a massive frame of brass and steel. The eyes of its maker glowed with pride as he looked upon his greatest work. He patted its rim lovingly, and said: "It is not a *perfect* lens; no glass of that size can be quite perfect; but it is *the best lens in the world!*" His pride was indeed justifiable, in this as in other specimens of his art.

He brought me to the long testing-gallery in the cellar—a sort of tunnel, extending underground some distance beyond the factory walls to permit the testing of long-focus objectives. As I recollect it, when a lens was fixed in a vertical position about midway in this room, a tiny ray of light shining through it was refracted to the further end of the tunnel and there formed a minute focal image. The lens would then receive its final testings and corrections by using the great telescope in the orchard.

And then Mr. Clark became delightfully reminiscent. He was speaking of that mighty testing-tube, which had stood there for many years and had been used for the correcting of many great lenses. He told of his discovery of the companion of Sirius, at a time when a large objective was being constructed for a mid-western university. It is now the principal instrument of the Dearborn Observatory. The senior Clark was then living and active, and he was desirous of testing the new lens on a very bright star, to ascertain the quality of the star-image under powerful magnification. (Even our non-professional readers know that a perfect star-image should be a very tiny disc, usually surrounded by two or more concentric diffraction-rings, and devoid of any wings or distortions even when viewed with a high-power eyepiece.) Sirius, the brightest of the fixed stars, was well situated for this purpose. The elder Clark attempted to point the mighty telescope at the desired object, but the apparatus was cumbersome and hard to handle. After several unsuccessful efforts, he desisted—saying to his son: "Here—see if you can get this confounded thing on Sirius." The younger Clark "got" it in a moment, and focused carefully. And then he quietly announced one of the most important astronomical discoveries of recent times. "Father," he said, "Sirius is *a double star!*" There was the dazzling tiny disc of the Dog-star, and there, close beside it, was the tinier and fainter companion. "The old gentleman never quite forgave me," said the junior Clark; "he would have made the discovery himself if he had only pointed the big tube straight."

Such was my interview with Alvan Clark, Jr., and such were my experiences in the modest edifice from which many optical masterpieces have gone forth. Mr. Clark, worthy son of a famous sire, was a man who loved his work and was proud of it—so proud that he liked to have it appreciated by others; and therefore he was willing to tell of the mysteries of his art and to show its workings even to a casual visitor like me. He possessed, perhaps equally with his gifted father, an infinite capacity for taking pains; nothing could leave the Clark workshop until the Clarks were satisfied with it—until it measured up to the standard of quality and efficiency which is the foundation of the firm's reputation. They say that in the making of the flint-glass of one of their great lenses, the Clarks used no less than eighteen discs of glass before one was found that would satisfy their rigid requirements.

Mr. Palmer, in his article, has testified to the enthusiasm and the

"commonsense goodness" of the senior Clark—a masterly appreciation. And I can say the same of his illustrious son—a man of gentle manner, of broad knowledge that extended far beyond the limits of his optical profession, of culture that was not a veneer, and of courtesy that led to the giving of an hour of his valuable time to a young intruder whose sole claim to consideration was a love for the science of the stars and a deep admiration for the famous firm which has done so much for astronomy.

134 Fuller Avenue, Central Falls, R. I.

PLANET NOTES FOR SEPTEMBER AND OCTOBER.

By CLIFFORD E. SMITH.

The *Sun* will continue to move southeast during this period in Leo and Virgo. Late in the day, September 23, Central Standard Time, the sun will cross the equator; an event which marks the beginning of fall. On October 16, it will be just north of Spica (α Virginis). The positions of the sun on September 1, October 1, and October 31, will be respectively R.A. $10^h\ 37^m$, Decl. $+8°\ 44'$, R.A. $12^h\ 25^m$, Decl. $-2°\ 42'$, and R.A. $14^h\ 17^m$, Decl. $-13°\ 43'$.

The phases of the *Moon* will occur as follows:

First Quarter	Sept.	4 at	5 A.M.	C.S.T.
Full Moon		11 "	7 A.M.	"
Last Quarter		17 "	9 P.M.	"
New Moon		25 "	4 P.M.	"
First Quarter	Oct.	3 at	8 P.M.	C.S.T.
Full Moon		10 "	3 P.M.	"
Last Quarter		17 "	9 A.M.	"
New Moon		25 "	10 A.M.	"

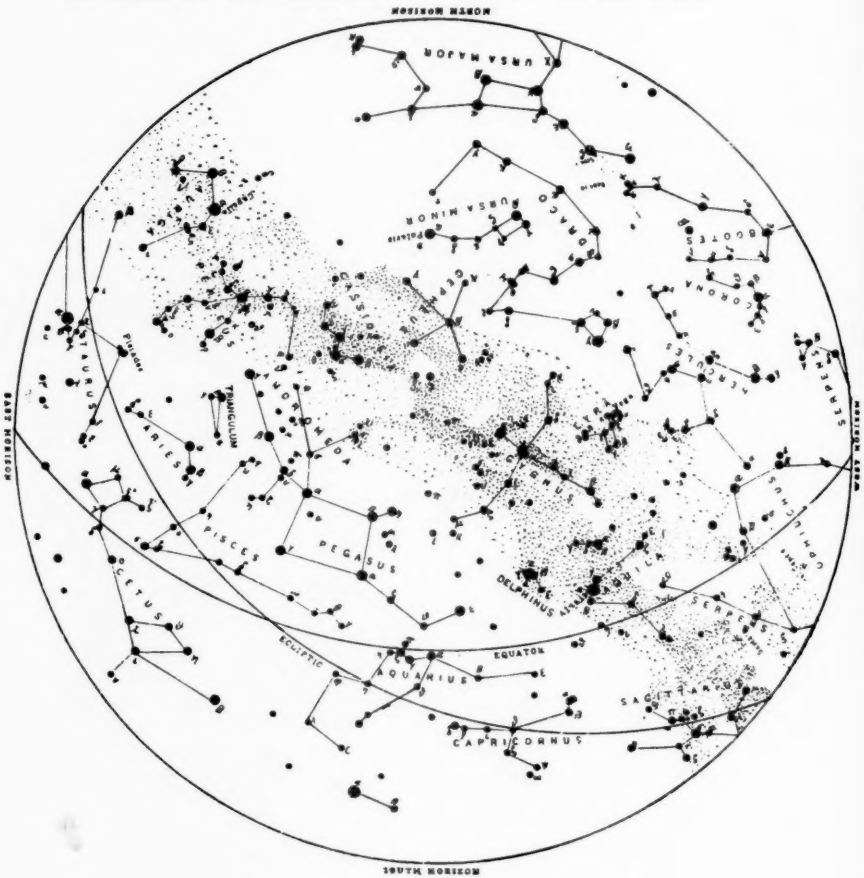
The moon will be at perigee (nearest the earth) on September 12 and October 11 and at apogee (farthest from the earth) on September 27 and October 25.

Mercury, during these months, will move from the central part of Leo, across Virgo into the central part of Libra. Superior conjunction will occur on September 2, and greatest elongation east of the sun will occur on October 18. Thus during the first part of September Mercury will be too near the sun to be visible, but about October 18, it will set about an hour and a half after sunset. On September 16 Mercury will be in conjunction with Mars. It is unfortunate that these planets will be too near the sun to be visible on that date because they will be so close that they would appear as a very bright double star separated by only six minutes of arc. Also Mercury will be in conjunction with Venus on September 6, but neither planet will be visible.

Venus will be in Leo. On September 18 it will be at inferior conjunction so that during September it will not be visible. During October it will be a morning star rising about two and a half hours before the sun during the middle of the month. It will be interesting to remember that during September the apparent motion of Venus will be westward. Ordinarily the planets move eastward in the sky.

Mars will move from the central part of Leo to the eastern part of Virgo. It will be too near the sun for favorable observation during these months. Conjunction with the sun will occur on October 21. Mars will be in conjunction with Mercury on September 16 as has been mentiond in the notes on Mercury.

Jupiter will be moving westward in Pisces. It will be in a position most favorable for observation during this period as it will be in opposition on September 22, and will be visible, therefore, during most of the night hours.



THE CONSTELLATIONS AT 9:00 P.M. OCTOBER 1.

Saturn will be in Scorpio and will be visible during the early hours of the night. On October 1 it will set about three and a half hours after the sun.

Uranus will be in opposition on September 25. Therefore, like Jupiter, it will be visible most of the night hours. It will also be in Pisces.

Neptune will be in Leo near Regulus (α Leonis). Until late in October it will be too close to the sun for favorable observation, but on October 31 it will rise about 4¼ hours before the sun.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1927		Star's Name	Magnitude	IMMERSION. Washington C.T. h m	IMMERSION. Angle from N °	EMERSION. Washington C.T. h m	EMERSION. Angle from N °	Duration h m
Sept.	8	χ Capricorni	5.3	21 35	69	22 56	249	1 21
	9	φ Capricorni	5.3	1 41	105	2 29	209	0 48
	9	161 B. Capricorni	6.4	18 35	127	19 15	201	0 41
	11	290 B. Aquarii	6.3	3 16	65	4 17	235	1 1
	11	30 Piscium	4.7	21 44	34	22 48	265	1 3
	11	33 Piscium	4.7	23 34	72	0 45	219	1 11
	13	26 Ceti	6.0	1 54	15	2 51	274	0 57
	16	148 B. Tauri	5.9	1 18	121	1 56	184	0 37
	20	82 Geminorum	6.3	2 29	128	3 18	228	0 49
	21	γ Cancri	4.7	2 29	66	3 22	300	0 54
	30	β^1 Scorpii	2.9	19 42	74	20 44	307	1 2
Oct.	6	37 Capricorni	5.7	17 49	146	18 12	181	0 23
	6	ε Capricorni	4.7	19 10	33	20 15	284	1 6
	6	κ Capricorni	4.8	22 41	35	23 44	271	1 3
	10	117 G. Piscium	6.5	21 12	66	22 20	227	1 7
	11	ν Piscium	4.7	5 48	124	6 17	189	0 29
	11	25 Arietis	6.5	23 10	72	0 20	222	1 10
	14	η Tauri	5.1	20 10	109	20 50	221	0 40
	16	52 B. Geminorum	6.5	4 21	49	5 28	306	1 8
	30	λ Sagitarii	2.9	19 13	81	20 24	266	1 11

Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, MIDNIGHT = 0^h

I. Mimas. Period 0^d 22^h6.

1927	d	h		d	h		1927	d	h		d	h	
Sept.	0	23.9	W	Sept. 4	18.4	W	Sept.	12	18.8	E	Sept. 21	17.7	W
	1	22.6	W	9	22.9	E		18	21.8	W	26	22.2	E
	2	21.2	W	10	21.5	E		19	20.5	W	27	20.8	E
	3	19.8	W	11	20.1	E		20	19.1	W	28	19.4	E

II. Enceladus. Period 1^d 8^h9.

Sept.	0	19.9	E	Sept. 7	16.4	E	Sept.	14	12.9	E	Sept. 22	18.3	E
	2	4.8	E	9	1.3	E		15	21.8	E	24	3.2	E
	3	13.7	E	10	10.2	E		17	6.7	E	25	12.1	E
	4	22.6	E	11	19.1	E		18	15.6	E	26	21.0	E
	6	7.5	E	13	4.0	E		20	0.5	E	28	5.9	E
								21	9.4	E	29	14.8	E

III. Tethys. Period 1^d 21^h3.

Sept.	1	14.1	E	Sept. 9	3.4	E	Sept.	16	16.7	E	Sept. 24	6.0	E
	3	11.4	E	11	0.7	E		18	14.0	E	26	3.3	E
	5	8.7	E	12	22.0	E		20	11.3	E	28	0.6	E
	7	6.0	E	14	19.3	E		22	8.6	E			

IV. Dione. Period 2^d 17^h7.

Sept.	2	1.2	E	Sept. 10	6.3	E	Sept.	18	11.5	E	Sept. 26	16.7	E
	4	18.9	E	13	0.0	E		21	5.2	E	29	10.4	E
	7	12.6	E	15	17.8	E		23	22.9	E			

V. Rhea. Period $4^d\ 12^h5$.

d	h	d	h	d	h	d	h
Sept. 4	19.8 E	Sept. 13	20.8 E	Sept. 22	21.8 E	Sept. 27	10.4 E
9	8.3 E	18	9.3 E				

VI. Titan. Period $15^d\ 23^h3$.

Sept. 8	5.3 E	Sept. 16	9.1 W	Sept. 24	5.1 E

VII. Hyperion. Period $21^d\ 7^h6$.

Sept. 1	16.7 W	Sept. 11	0.2 E	Sept. 22	23.1 W

VIII. Japetus. Period $79^d\ 22^h1$.

Aug. 20	11.0 W	Sept. 10	12.0 S

NOTE:—E, Eastern Elongation; W, Western Elongation; S, Superior Conjunction (north of planet); I, Inferior Conjunction (south of planet).

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, MIDNIGHT = 0^h

1927	h	m			1927	h	m		
Sept. 0	19	44.8	I	Ec. D.	Sept. 15	20	55	I	Tr. I.
	22	32	I	Oc. R.		22	59	I	Sh. E.
1	19	10	I	Sh. E.		23	8	I	Tr. E.
	19	40	I	Tr. E.	16	1	41.7	II	Ec. D.
	20	30.9	II	Ec. D.		18	3.3	I	Ec. D.
2	0	7	II	Oc. R.		20	26	I	Oc. R.
3	19	0	II	Tr. E.	17	20	42	II	Sh. I.
5	20	14	III	Tr. I.		20	59	II	Tr. I.
	21	14	III	Sh. E.		23	21	II	Sh. E.
	22	46	III	Tr. E.		23	31	II	Tr. E.
6	3	10.9	I	Ec. D.	20	2	22	III	Sh. I.
7	0	22	I	Sh. I.		2	45	III	Tr. I.
	0	46	I	Tr. I.	21	4	11	I	Sh. I.
	2	36	I	Sh. E.		4	13	I	Tr. I.
	2	58	I	Tr. E.	22	1	29.6	I	Ec. D.
	3	0	IV	Sh. I.		3	44.5	I	Ec. R.
	21	39.7	I	Ec. D.		22	39	I	Sh. I.
8	0	16	I	Oc. R.		22	39	I	Tr. I.
	18	50	I	Sh. I.	23	0	51	I	Tr. E.
	19	12	I	Tr. I.		0	53	I	Sh. E.
	21	4	I	Sh. E.		4	17	2	Oc. D.
	21	24	I	Tr. E.		19	23.6	3	Ec. R.
	23	6.2	II	Ec. D.		19	56	I	Oc. D.
9	2	22	II	Oc. R.		21	23	IV	Sh. I.
	18	42	I	Oc. R.		22	13.2	I	Ec. R.
10	18	44	II	Tr. I.		23	31	IV	Sh. E.
	20	43	II	Sh. E.	24	19	17	I	Tr. E.
	21	16	II	Tr. E.		19	22	I	Sh. E.
12	22	20	III	Sh. I.		23	13	II	Tr. I.
	23	30	III	Tr. I.		23	20	II	Sh. I.
13	1	14	III	Sh. E.	25	1	46	II	Tr. E.
	2	3	III	Tr. E.		1	58	II	Sh. E.
14	2	16	I	Sh. I.	26	20	12.3	II	Ec. R.
	2	30	I	Tr. I.	29	3	14	I	Oc. D.
	23	34.6	I	Ec. D.	30	0	22	I	Tr. I.
15	2	0	I	Oc. R.		0	34	I	Sh. I.
	20	45	I	Sh. I.		2	35	I	Tr. E.
						2	48	I	Sh. E.

NOTES—I. denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1927							
					Sept.				Oct.			
	h m	° ′		d h	d h		d h		d h		d h	
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	3 18				8 6			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	8 4		23 12		8 21		24 5	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	2 15		17 14		2 13		17 12	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 14		18 19		7 3		19 9	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	9 6		26 9		13 13		30 16	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	9 15		23 8		7 1		20 19	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	9 10		23 18		8 3		22 11	
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 11		26 1		4 19		22 9	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	6 5		22 3		8 1		23 22	
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	14 1				16 8			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 4		22 9		9 12		26 19	
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	9 4		24 18		4 8		19 23	
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	4 6		20 2		5 21		23 17	
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	2 6		18 21		5 12		22 3	
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	2 19		18 13		4 9		20 3	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	2 14		28 23		12 4		25 9	
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	7 15		20 5		9 2		21 17	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	3 7		28 3		10 13		22 23	
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	8 22		22 6		5 14		18 22	
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	7 22		24 6		10 15		26 23	
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	6 20		18 21		12 23		25 0	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	8 12		25 20		4 12		21 20	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	4 14		25 9		5 19		26 15	
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	4 17		20 18		6 18		22 19	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4 19		16 6		9 5		20 16	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	8 8		25 3		11 22		23 3	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	6 23		23 9		9 19		26 4	
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	6 5		21 11		6 17		21 23	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	13 0		25 5		7 10		31 20	
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	5 7		19 15		11 3		25 11	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	6 0		19 15		10 2		23 17	
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	6 17		25 7		4 14		23 5	
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	8 20		22 1		11 21		25 2	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	8 15		25 11		3 20		20 15	
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	6 2		18 22		8 5		21 2	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	6 7		20 21		5 2		19 23	
X Carinæ	8 29.1	—58 53	7.9— 8.7	0 13.0	6 17		22 23		9 5		25 11	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	5 21		24 21		4 8		23 8	
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	7 19		21 12		12 1		25 17	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	8 11		20 8		8 3		20 1	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	5 19		26 1		9 12		23 0	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	3 12		18 8		10 14		25 11	
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	8 18		21 23		5 4		24 23	
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	4 17		22 8		9 22		27 12	
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	5 3		19 19		4 10		19 2	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	4 17		18 7		8 16		22 5	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	7 20		22 20		7 20		22 20	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	10 10		29 15		9 5		28 9	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1927							
					Sept.				Oct.			
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	6 21	21 18	6 15	21 12				
SX Hydræ	39.0	−26 23	8.6—12.7	2 21.5	1 20	22 5	9 14	26 23				
δ Libræ	14 55.6	− 8 07	4.8— 6.2	2 07.9	4 23	18 22	9 21	23 20				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	6 11	20 6	10 23	24 19				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.4	9 19	24 16	3 2	19 22				
SS Libræ	15 43.4	−15 14	9.3—11.5	0 18.4	9 17	24 2	8 11	22 21				
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	3 12	18 5	10 5	22 21				
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	6 7	22 20	9 8	25 20				
R Aræ	31.1	−56 48	6.8— 7.9	4 10.2	8 17	26 10	5 7	22 23				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	3 8	24 2	14 20					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	3 16	17 7	7 16	21 7				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	1 16.2	8 11	25 6	12 0	28 18				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	8 17	21 0	9 12	21 19				
TX Herculis	15.4	+42 00	8.3— 9.0	2 01.4	8 20	21 5	9 17	22 2				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	2 4	16 22	9 0	23 19				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	7 12	23 21	10 6	26 15				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	5 17	20 19	5 21	20 23				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	11 7	26 19	12 7	27 19				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	9 2	25 2	11 1	28 0				
WX Sagittarii	53.6	−17 24	9.2—10.8	2 03.1	10 11	27 11	14 12	31 13				
WY Sagittarii	17 54.9	−23 01	9.5—10.6	4 16.0	9 14	23 14	7 15	21 15				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	11 5	26 17	12 5	22 13				
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	6 21	21 9	5 21	20 9				
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	5 10	19 6	9 23	23 18				
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	8 20	23 23	9 2	24 5				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	8 3	22 10	6 18	21 2				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	5 23	20 5	4 10	18 16				
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	11 2	27 16	6 0	22 15				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 19	22 19	9 18	26 18				
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	7 5	20 12	10 10	23 17				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	5 23	18 21	1 19	27 15				
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	3 10	18 16	3 23	19 6				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	5 23	21 3	6 6	21 10				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	7 9	21 9	6 4	20 14				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	5 13	23 11	11 9	29 7				
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	8 19	22 7	5 20	19 8				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	8 13	23 6	8 0	22 17				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	5 8	21 2	6 19	22 13				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	7 23	21 0	4 1	23 15				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	6 20	24 21	6 21	24 21				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	9 10	22 16	5 23	19 5				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 7	21 0	9 7	23 0				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	1 2	17 23	4 19	21 16				
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	8 10	22 0	5 14	19 3				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	4 23	18 18	9 11	23 6				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0		17 9		25 4				
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	9 6	23 16	8 2	22 12				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	9 19	28 4	7 9	25 19				
Y Cygni	48.1	+34 17	7.1— 7.9	2 23.9	6 15	24 15	3 14	21 14				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	5 12	20 17	5 21	21 2				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	2 10	22 14	2 17	22 22				
RY Aquarii	21 14.8	−11 14	8.8—10.4	1 23.2	6 18	22 12	8 6	23 23				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	11 19		13 2					
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	7 15	22 21	8 2	23 7				
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	9 19	25 9	10 22	26 12				
VW Pegasi	51.7	+32 42	10.0—10.6	5 06.4	9 5	25 1	10 19	21 8				
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	6 16	21 17	6 18	21 20				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	7 8	23 20	10 8	26 20				

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1927							
					Sept.				Oct.			
	h m	° ′		d h	d h	d h	d h		d h	d h		
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7			29	10				
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	10	1	26	7	4	11	20	18
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	3	1	18	13	4	1	19	12
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	5	1	19	20	4	15	19	10
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	9	14	25	11	11	9	27	6
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	8	10	24	0	9	14	25	4
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0			16	9	2	19	19	5
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6	12	23	16	10	19	28	0
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	7	15	29	21	11	1	22	3
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	5	1	28	7	9	23	21	13
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	6	6	21	14	6	22	22	5
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	8	19	29	1	9	4	29	11
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	7	7	22	18	8	5	23	15
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	7	14	24	5	5	6	21	20
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	6	9	21	13	6	16	21	19
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	14	13			11	13		
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	5	15	20	13	5	11	20	9
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	8	23	24	19	2	17	18	13
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	4	10	24	18	4	21	25	5
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	1	12	23	18			16	1
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3	2	18	23	4	20	20	18
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	6	5	19	14	9	16	23	1
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	8	2	17	9	5	23	24	12
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	3	16	21	4	8	15	26	3
Z Leonis	9 46.4	+27 22	7.9— 9.6	56 08.7					7	21		
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	8	14	22	3	5	17	19	7
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6	23	20	3	9	23	23	4
S Muscæ	12 07.4	—69 36	6.4— 7.3	9 15.8	6	22	26	5	5	21	25	4
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	5	5	21	3	7	2	23	1
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	3	3	23	8	6	19	20	6
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	10	1	21	16	9	3	20	19
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	10	3	24	5	8	6	22	8
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5	2	16	19	22	7	5	24	11
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	4	8	20	17	7	3	23	12
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	4	13	18	14	9	15	23	16
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	6	8	21	4	5	23	20	19
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	10	21	21	21	8	8	24	20
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5	0	18	2	10	17	25	19
R Trian.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	5	0	18	13	8	21	22	10
S Trian.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	4	5	23	5	5	20	24	19
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	9	13	29	1	8	19	28	7
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	8	15	26	8	5	5	22	22
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	8	5	20	8	8	13	20	16
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	7	12	21	13	5	13	19	14
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	6	15	23	18	10	21	27	23
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	8	12	23	17	8	21	24	2
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	4	17	22	1	9	8	20	21
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	9	18	23	6	6	17	20	5
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	9	10	30	2	10	11	20	19
RZ Lyræ	39.9	+32 42	9.9—11.2	0 12.3	6	13	21	21	7	5	22	13
RT Scuti	44.1	—10 30	9.1— 9.7	0 11.9	3	0	17	21	10	4	25	1
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	6	18	24	22	4	1	22	5

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1927							
					Sept.				Oct.			
	h m	° ′		d h	d	h	d	h	d	h	d	h
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	7	16	21	17	5	18	19	19
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	5	3	19	3	10	3	24	3
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	9	9	25	8	3	8	27	6
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8	13	23	23	9	8	24	17
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	1	21	23	8	7	17	22	1
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	2	17	19	12	6	6	23	0
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	5	12	24	11	7	2	19	18
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	10	16	27	2	13	11	29	20
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5	23	23	17	2	13	20	7
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	8	10	23	0	7	14	22	3
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	3	3	17	11	8	23	23	6
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	6	22	21	15	6	8	21	1
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	2	16	18	9	11	23	27	16
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	7	19	21	14	5	9	19	3
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2	17	22	4	11	15	31	2
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	9	19	27	3	5	18	23	1
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4	20	20	23	7	1	23	3
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	6	7	28	2	9	0	30	18
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	4	16	23	22	13	3	25	23
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	9	23	29	22	9	21	29	19
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	6	4	22	12	8	20	25	4
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	7	23	24	6	10	14	21	11
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	10	23	23	13	12	10	25	1
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	10	0	22	4	4	7	28	13
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	3	15	17	14	8	13	22	12

Monthly Report of the American Association of Variable Star Observers, for the Months of May and June, 1927.

Herewith is presented the usual summer double report of over twenty-six hundred observations by two score observers on three hundred and seventy variable stars; a record to be truly proud of.

U Geminorum disappeared in the western twilight before it rose to maximum. SS Aurigae and SS Cygni were both at maximum during the interval covered by these observations, the latter on two different occasions.

We welcome an excellent contribution of observations on southern stars by Sr. Dartayet of Buenos Aires, Argentina, as well as a fine series of observations by Sig. Fresa of Capodimonte, Italy.

We regret to report the sudden illness of President Godfrey which necessitated his removal to the Bridgeport, Conn., hospital. But the latest news brings word that he is now well on the road to recovery.

It appears that many of our members, particularly those holding high office, are now touring Europe. Vice President Farnsworth and Past President Young are summering in England, Secretary Olcott and Treasurer Jordan are visiting Italy. Mr. D. B. Pickering has just returned from an extended trip through France, Germany, Austria, and the Netherlands. The recording secretary spent a delightful week-end recently as the guest of the Springfield (Vt.) Telescope Makers and told them something of the fascination of variable star observing. He feels certain that at least a few of this enthusiastic group of telescope makers will take up this line of investigation.

The event of outstanding interest to the Association was the Spring meeting held at the Yale Observatory in May as the guests of Dr. Frank Schlesinger. Over thirty members and their friends were royally entertained by Director Schlesinger and his corps of aides.

The Council met at the Observatory on Friday evening, May 20, and elected the following new members:

Frank Schlesinger, New Haven, Conn.
Ernest W. Brown, New Haven, Conn.
Goodrich Watkins, Caldwell, Idaho.
Harold P. Spears, Binghamton, N. Y.
Charles Bodmer, New Britain, Conn.
V. A. Poynter, New York, N. Y.
L. C. Larson, Santa Barbara, Calif.
J. C. Howe, Oakland, Calif.
Mildred E. Gray, Hyde Park, Mass.
M. S. Sloan, Brooklyn, N. Y. (Life).

On Saturday morning the Observatory was open to inspection and the instruments and their operation were painstakingly explained by the staff. The business meeting opened at 2 P.M. with President Godfrey in the chair. Secretary Olcott was prevented from attending, due to a severe illness, and Mr. C. W. Elmer was chosen Secretary Pro-Tem. Dr. Brown reported on Occultation work, and exhibited several movie reels of the 1925 Solar Eclipse. Several papers were read, two of which are to appear in POPULAR ASTRONOMY.

The following slate for Council Members to be elected at the October meeting was presented by the Nominating Committee, four to be chosen for a term of two years:

Arthur W. Butler, New York, N. Y.
Willard J. Fisher, Cambridge, Mass.
Margaret Harwood, Nantucket, Mass.
Wm. Tyler Olcott, Norwich, Conn.

Reports of officers and committees were duly read, approved and ordered filed. Mr. Waterfield presented the Association some "original notes on Variables" made in 1863-64 by his grandfather, Sir Wm. Herschel. After the taking of the group photograph, tea was served at the Lawn Club, through the kindness of Mrs. Schlesinger and Miss Brown. The usual dinner was held in the evening and cordiality, wit and good humor ran high. George C. Waldo acted as toastmaster, with credit to himself and the Association. After-dinner remarks were made by newly elected members, our hosts, and the "Old Guard."

The meeting wound up unofficially on Sunday with visits to the private observatories of President Godfrey in Stratford, and Mr. Waldo in Fairfield. The following members were in attendance:

Leah B. Allen, Wellesley, Mass.
P. R. Allen, Auburndale, Mass.
L. E. Barnes, Bethlehem, Pa.
Harriet E. Bigelow, Northampton, Mass.
L. J. Boss, No. Scituate, R. I.
E. W. Brown, New Haven, Conn.
Leon Campbell, Cambridge, Mass.
Inez L. B. Clough, Waterbury, Conn.
L. E. Cunningham, Cambridge, Mass.
C. W. Elmer, New York, N. Y.
Alice H. Farnsworth, So. Hadley, Mass.
C. C. Godfrey, Stratford, Conn.
Margaret Harwood, Nantucket, Mass.
O. D. Havard, Allentown, Pa.
Wm. Henry, Brooklyn, N. Y.
E. H. Jones, Somerville, Mass.
M. J. Jordan, Boston, Mass.
Frank Schlesinger, New Haven, Conn.
Harlow Shapley, Cambridge, Mass.
Helen M. Swartz, So. Norwalk, Conn.
R. O. Suter, Jr., Cambridge, Mass.
G. C. Waldo, Fairfield, Conn.
W. F. H. Waterfield, Cambridge, Mass.
J. E. G. Yalden, Leonia, N. J.
Anne S. Young, So. Hadley, Mass.

The annual meeting will be held at Harvard Observatory on October 22. The next Spring Meeting is scheduled to be held at Vassar in May, 1928.

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

April 0 = J.D. 2424971; May 0 = J.D. 2425001; June 0 = J.D. 2425032.

V SCL
000339
946 9.4 Bl
967 9.6 Bl
S SCL
001032
946 10.8 Bl
T CET
001620
912 6.0 Kd
T AND
001726
001 9.2 Ch
038 11.5 Pt
T CAS
001755
976 8.3 L
999 7.6 Jo
000 7.7 L
008 7.8 Jo
020 7.4 L
029 7.5 Jo
033 7.8 Jo
038 7.8 Pt
R AND
001838
038 12.4 Pt
S TUC
001862
947[12.5 Sm
963 13.5 Bl
969[11.9 Sm
975 13.0 Bl
985[12.4 Bl
T PHE
002546
941[12.2 Sm
963 13.4 Bl
975 11.5 Bl
985 9.9 Bl
U CAS
004047
038 12.7 Pt
RW AND
004132
038 9.6 Pt
X SCL
004435
946 11.4 Bl
963 11.4 Bl
967 11.3 Bl
RV CAS
004746a
038 10.4 Pt
— CAS
004746b
038 10.8 Pt
W CAS
004958
020 11.0 Pt
038 9.4 Pt

U TUC
005475
943 13.0 En
945[12.9 Sm
961[11.8 En
963[13.8 Bl
969[12.9 Sm
996[12.9 Sm
S CAS
011272
992 11.4 Rh
020 11.6 Pt
038 11.9 Pt
R PSC
012502
946 8.3 Bg
RU AND
013238
964 10.5 Ch
040 11.6 Pt
Y AND
013338
964 10.8 Ch
040 12.1 Pt
X CAS
014958
990 11.2 Bn
997 11.2 Bn
004 11.3 Bn
009 11.5 Bn
040 12.3 Pt
RR ARI
015023
912 5.8 H
913 5.5 H
914 5.9 H
U PER
015254
040 8.2 Pt
XX PER
015654
964 8.6 Ch
R ARI
021024
905 9.3 Wb
913 9.6 Wb
W AND
021143a
040 12.0 Pt
T PER
021258
964 9.0 Ch
040 8.6 Pt
Z CEP
021281
992[14.5 Rh

o CET
021403
938 7.4 Kd
943 7.2 En
964 8.1 Ch
S PER
021558
040 9.4 Pt
RR PER
022150
040 10.2 Pt
R FOR
022426
946 9.4 Bl
963 10.5 Bl
967 9.8 Bl
975 10.7 Bl
985 10.6 Bl
RR CEP
022960
992 14.4 Rh
000 14.1 L
W PER
024356
040 9.8 Pt
R HOR
025050
943 7.6 En
945 8.1 Sm
945 8.5 Ht
946 8.3 Bl
951 8.5 Ht
952 8.3 Sm
959 8.8 Ht
961 8.6 En
963 8.7 Bl
965 9.2 En
965 9.2 Ht
967 8.9 Bl
969 9.2 Sm
970 9.2 Ht
975 9.8 Sm
975 9.1 Bl
985 9.5 Bl
985 10.0 Ht
990 10.6 Ht
996 10.3 Sm
999 10.8 Bl
T HOR
025751
941 12.2 Sm
946 11.0 Bl
947 11.0 Sm
963 9.5 Bl
967 9.5 Bl
969 10.2 Sm
975 9.6 Sm
975 9.3 Bl
985 8.5 Bl
996 8.3 Sm
999 7.8 Bl

U ARI
030514
946 13.9 Bg
952 13.5 Bg
955 13.3 Bg
960 13.2 Bg
967 12.8 Bf
Y PER
032043
040 8.5 Pt
R TAU
042209
946 10.6 Bg
955 10.7 Bg
960 10.8 Bg
967 11.9 Bf
971 11.8 Bf
988 12.4 Bf
992 13.1 Bf
996 13.0 Bf
S TAU
042309
946 15.6 Bg
955[13.6 Bg
960[14.8 Bg
967 15.0 Bf
971[14.8 Bf
988[13.1 Bf
992[13.9 Bf
996[13.9 Bf
T CAM
043065
976 10.1 L
998 9.1 L
001 8.8 Pt
020 8.5 L
040 8.8 Pt
R RET
043263
943 9.0 En
945 8.7 Sm
945 8.4 Ht
946 8.3 Bl
951 7.5 Ht
952 7.8 Sm
959 7.4 Ht
961 7.3 En
963 7.4 Bl
965 7.1 En
965 6.8 Ht
967 7.2 Bl
969 6.8 Sm
970 6.9 Ht
975 7.0 Bl
985 6.9 Ht
985 6.6 Bl
990 7.2 Ht
996 7.2 Sm
997 7.2 Ht
999 7.5 Bl

X CAM
043274
001 11.0 Pt
040 12.8 Pt
R DOR
043562
943 5.4 En
945 5.4 Ht
945 5.2 Sm
946 5.6 Bl
951 5.3 Ht
952 5.2 Sm
959 5.5 Ht
961 5.8 En
965 5.5 Ht
967 5.8 Bl
969 5.8 Sm
970 5.5 Ht
975 5.5 Bl
985 5.6 Bl
985 5.2 Ht
990 5.4 Ht
996 5.8 Sm
997 5.4 Ht
999 5.5 Bl
R CAE
043738
945 11.5 Ht
945 11.5 Sm
946 11.4 Bl
963 11.0 Bl
965 11.0 Ht
967 10.9 Bl
969 11.2 Sm
970 11.1 Ht
975 10.7 Bl
985 10.6 Bl
985 10.9 Ht
990 10.9 Ht
996 10.9 Sm
997 10.6 Ht
999 10.3 Bl
R PIC
044349
946 6.0 Bl
950 6.8 Dr
954 6.8 Dr
962 6.8 Dr
963 6.9 Dr
963 6.8 Bl
967 6.6 Bl
968 7.0 Dr
969 7.1 Dr
974 7.2 Dr
975 7.3 Bl
978 7.4 Dr
981 7.4 Dr
982 7.5 Dr
984 7.6 Dr

R PIC
044349
985 7.4 Bl
987 7.6 Dr
988 7.6 Dr
999 8.0 Bl
V TAU
044617
945 5.2 Ch
R LEP
045514
886 9.3 Wb
905 8.9 Wb
915 9.3 Wb
959 7.8 Fr
960 7.8 Fr
961 7.8 Fr
962 7.7 Fr
963 7.7 Fr
966 7.7 Fr
970 9.0 Ch
976 7.6 L
977 7.3 Fr
979 7.2 Fr
V ORI
050003
970 9.4 Ch
995 10.5 Ch
T LEP
050022
946 9.3 Bl
963 10.1 Bl
967 10.2 Bl
975 10.3 Bl
985 10.3 Bl
S PIC
050848
943[12.9 En
945[12.9 Sm
947[12.9 En
963 12.7 Bl
965[12.9 En
969[12.9 Sm
975[12.2 Sm
975 12.5 Bl
985 12.0 Bl
996 11.9 Sm
999 10.8 Bl
R AUR
050953
975[12.8 Ch
001 13.6 Pt
T PIC
051247
941[13.1 Sm
947[12.5 En
963[13.5 Bl
965[12.5 En
969 13.3 Sm
975[12.5 Sm
990 11.7 Ht

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T PIC	T ORI	SU TAU	R COL	X AUR	Y MON
051247	*053005a*	054319	*054629*	060450	065111
996 11.8 Sm	984 10.8 L	984 9.9 L	965 10.3 Ht	970 11.5 Ch	970 9.8 Ch
997 11.5 Ht	989 11.3 B	989 9.7 B	965 10.3 En	991 11.6 Ch	995 11.4 Ch
T COL	001 10.0 Pt	995 10.3 Ch	967 10.6 Bl	000 11.7 B	000 11.3 Ya
051533	002 10.0 Pt	999 9.9 Pt	969 10.2 Sm	000 11.4 Ch	001 11.7 Pt
943 11.0 En	S CAM	000 10.1 L	970 10.4 Ht	001 11.2 Pt	X MON
945 10.5 Sm	053068	001 10.0 Pt	975 10.9 Bl	008 11.3 Ch	*065208*
945 10.7 Ht	001 8.4 Pt	002 10.0 Pt	985 11.3 Bl	V AUR	973 8.0 Ch
946 10.0 Bl	040 8.4 Pt	009 10.0 Cd	985 11.7 Ht	061647	976 7.7 L
947 10.2 En	RR TAU	011 9.8 Pt	990 11.8 Ht	992 11.1 B	989 7.7 L
950 10.0 Dr	053326	S COL	996 11.5 Sm	V MON	995 8.1 Ch
951 9.9 Ht	946 12.1 Bg	*054331*	997 12 4 Ht	061702	001 8.4 Cb
952 10.1 Sm	952 12.4 Bg	943 10.2 En	000 11.8 Bl	973 10.5 Ch	R LYN
954 9.9 Dr	955 11.8 Bg	945 10.0 Sm	U ORI	995 11.1 Ch	065355
959 9.7 Ht	960 11.9 Bg	945 10.2 Ht	054920a	— AUR	976 12.4 Ch
961 9.3 En	967 13.2 Bf	946 9.8 Bl	975 11.6 Ch	062047	021 10 2 Ie
963 9.0 Bl	971 12.8 Bf	947 10.4 En	990 12.1 B	007 9.2 Be	V CMI
963 9.0 Dr	992 13.0 Bf	951 10.8 Ht	993 10.5 Gb	007 9.3 L	070109
964 9.0 Dr	993 13.1 Bg	952 10.5 Sm	001 12.6 Pt	013 8.8 L	995[11.0 Ch
965 9.4 Ht	996 12.6 Bf	959 11.2 Ht	V CAM	016 9.0 L	R GEM
965 9.2 En	RU AUR	961 11.0 En	054974	026 9.0 L	070122a
967 8.5 Bl	053337	963 10.7 Bl	028 11.1 Ie	029 9.1 L	964 10.3 Ch
968 9.1 Dr	001[12.4 Pt	965 11.2 Ht	040 10.8 Pt	029 9.3 Be	977 10.4 Ch
969 9.0 Dr	U AUR	965 11.0 En	Z AUR	U LYN	991 10.8 Al
969 8.7 Sm	053531	967 11.2 Bl	055353	063159	991 10.8 Ch
970 8.7 Ht	975 12.5 Ch	969 11.1 Sm	970 10.6 Ch	998 13.8 B	999 11.0 Pt
974 8.9 Dr	001 13.5 Pt	970 11.5 Ht	989 10.2 B	R MON	000 10.2 B
975 8.9 Dr	Y TAU	975 11.4 Bl	995 10.5 Ch	063308	024 11.8 Pt
975 8.3 Bl	053920	985 11.5 Bl	999 9.9 Pt	987[11.5 B	Z GEM
978 8.7 Dr	924 6.9 Fr	990 11.5 Ht	001 9.9 Pt	001 10.5 Pt	070122b
981 8.5 Dr	925 9.9 Fr	996 11.6 Sm	002 10.0 Pt	Nov. PIC	999 12.5 Pt
982 8.5 Dr	929 6.7 Fr	997 11.9 Ht	005 10.1 Pt	*063262*	000 12.4 B
984 8.5 Dr	932 7.2 Fr	000 12.0 Bl	009 10.0 Pt	943 6.2 En	024 12.4 Pt
985 8.1 Bl	939 6.9 Fr	Z TAU	011 10.1 Pt	945 6.5 Sm	TW GEM
985 8.4 Ht	940 6.8 Fr	054615a	017 10.0 Pt	945 6.4 Ht	070122c
987 8.6 Dr	942 6.8 Fr	946 13.7 Bg	020 10.0 Pt	947 6.5 Sm	999 7.8 Pt
988 8.4 Dr	944 6.8 Fr	960 13.8 Bg	024 10.0 Pt	951 6.5 Ht	000 8.4 B
990 8.3 Ht	945 6.9 Fr	967 13.2 Bf	026 10.0 Pt	953 6.2 En	024 8.0 Pt
992 8.3 Dr	956 6.7 Fr	971 13.4 Bf	027 9.8 Pt	959 6.2 En	R CMI
996 8.1 Sm	957 6.7 Fr	992 14.0 Bf	032 10.0 Pt	965 6.3 Ht	070310
997 7.5 Ht	958 6.6 Fr	RV TAU	033 10.2 Pt	965 6.2 En	928 9.1 Fr
999 7.6 Bl	959 6.7 Fr	054615b	038 9.9 Pt	970 6.5 Ht	929 9.1 Fr
S AUR	960 6.8 Fr	992 13.2 Bf	039 10.0 Eb	972 6.5 Sm	932 9.3 Fr
052034	961 6.7 Fr	RU TAU	039 10.0 Kz	973 6.5 Ht	933 9.5 Fr
970 10.5 Ch	962 6.7 Fr	054615c	042 10.0 Pt	985 6.4 Ht	940 9.6 Fr
975 10.5 Ch	963 5.7 Fr	946 11.6 Bg	R OCT	990 6.5 Ht	942 9.7 Fr
979 9.1 L	965 6.6 Fr	960 12.1 Bg	*055686*	997 6.3 Ht	945 9.7 Fr
992 9.6 B	966 6.6 Fr	967 12.9 Bf	941 9.1 Sm	001 6.4 Ht	956 9.8 Fr
994 10.0 Sg	968 6.5 Fr	971 13.0 Bf	947 8.7 Sm	S LYN	957 9.8 Fr
995 9.6 Pt	975 6.5 Fr	R COL	947 9.2 Bl	063558	958 9.8 Fr
000 9.8 L	977 6.6 Fr	*054629*	952 8.6 Sm	998 13 4 B	959 9.9 Fr
001 9.0 Pt	979 6.5 Fr	943 10.1 En	963 8.3 Bl	001 13.1 Pt	960 9.8 Fr
W AUR	990 6.5 Fr	945 10.2 Sm	967 8.4 Bl	X GEM	961 10.0 Fr
052036	992 6.5 Fr	945 9.9 Ht	969 8.8 Sm	064030	962 9.9 Fr
975[12.2 Ch	993 6.4 Fr	947 10.1 Bl	975 9.0 Bl	986 10.0 Bn	963 9.9 Fr
992[12.6 B	997 6.5 Fr	947 10.2 En	985 9.2 Bl	989 9.3 B	966 9.8 Fr
T ORI	999 6.5 Fr	951 10.3 Ht	999 9.2 Bl	990 9.2 Bn	968 9.9 Fr
053005a	SU TAU	952 10.2 Sm	X AUR	997 8.7 Bn	976 11.0 L
974 10.7 L	054319	959 10.4 Ht	060450	001 8.6 Bn	979 10.0 Fr
976 10.4 L	966 10.5 Ch	961 10.3 En	963 11.2 Ch	004 8.5 Bn	989 11.0 L
979 10.2 L	975 10.1 Ch	963 10.4 Bl	966 11.3 Ch	008 8.3 Bn	990 10.0 Fr

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CMi	U CMi	RT Hya	T Cnc	R Car	R LMi
070310	073508	*082405*	085120	*093962*	093934
993 10.1 Fr	024 9.2 Pt	989 8.0 B	944 8.8 Fr	951 7.3 Ht	995 7.5 Gs
995 11.0 Ch	S Gem	001 7.7 Pt	945 8.7 Fr	952 7.3 Sm	998 6.8 Ch
000 10.6 B	073723	011 7.7 B	958 8.7 Fr	953 7.3 En	998 6.9 L
001 10.1 Fr	981[13.6 GC	020 7.9 Pt	959 8.8 Fr	954 7.5 Dr	001 6.9 Pt
014 10.8 L	990 13.9 B	R Cha	960 8.7 Fr	959 6.8 Ht	006 7.0 Ch
R Vol	000[13.6 Cl	*082476*	961 8.8 Fr	962 7.1 Dr	006 7.0 B
070772	W Pup	943 11.7 En	962 8.8 Fr	961 6.9 En	014 6.8 L
943 12.2 En	*074241*	945 11.6 Sm	963 8.9 Fr	963 6.7 Bl	020 7.4 Pt
945 12.2 Ht	944 9.4 En	947 11.2 Bl	966 8.8 Fr	963 7.1 Dr	022 7.4 Wa
945 11.3 Sm	945 9.2 Ht	947 11.3 En	968 8.8 Fr	964 7.1 Dr	028 7.5 Ya
947 11.8 En	947 9.3 Sm	961 10.0 En	970 8.6 Fr	965 6.7 Ht	039 7.7 Eb
961 11.6 En	947 9.0 Bl	963 10.3 Bl	970 9.6 Ch	965 6.6 En	039 6.8 Kz
965 11.6 En	961 8.4 En	967 10.2 Bl	977 9.8 Ch	967 6.2 Bl	R Leo
965 12.2 Ht	963 8.0 Bl	969 10.6 Sm	979 8.6 Fr	969 6.6 Sm	094211
969 11.0 Sm	965 8.1 Ht	975 9.5 Bl	990 8.6 Fr	969 6.9 Dr	905 6.0 Wb
970 11.8 Ht	965 8.5 En	985 9.4 Bl	992 8.6 Fr	974 6.8 Dr	913 6.0 Wb
985 10.6 Ht	967 8.7 Bl	000 9.0 Bl	993 8.6 Fr	975 6.8 Dr	918 6.5 Wb
991 10.4 Ht	969 8.5 Sm	X UMa	994 9.9 Ch	975 6.0 Bl	971 7.7 Ch
997 10 2 Ht	973 8.9 Ht	083350	995 8.6 Fr	975 6.1 Sm	977 8.2 Ch
V Gem	975 8.7 Bl	998 10.3 B	001 8.6 Pt	976 6.2 En	977 8.0 Jn
071713	985 8.8 Bl	001 10.4 Pt	020 8.5 Pt	978 6.3 Dr	988 7.8 Wb
990 12.9 B	985 9.0 Ht	020 9.5 Pt	T Pyx	981 6.1 Dr	992 8.5 Ch
001 12.0 Pt	991 9.4 Ht	S Hya	*090031*	981 6.0 En	993 7.7 Sg
024 10.1 Pt	997 9.6 Ht	084803	963 [u Bl	982 6.0 Dr	993 8.6 Gz
S CMi	000 10.0 Bl	970 7.7 Ch	V UMa	984 5.9 Dr	993 7.8 Wb
072708	T Gem	977 7.4 Ch	090151	984 5.9 En	995 7.9 Jo
905 7.3 Wb	074323	989 7.5 Ch	998 10.4 B	985 6.2 Ht	995 8.3 Wa
964 9.8 Ch	981[13.1 GC	989 7.4 B	W Cnc	985 5.9 Bl	998 8.5 Ch
976 9.1 L	991[13.1 Ch	994 7.6 Ch	090425	987 6.2 Dr	998 8.8 Cb
977 9.9 Ch	U Pup	997 8.0 Lg	976 8.8 L	988 6.1 Dr	999 9.0 Jn
987 9.8 B	*075612*	999 8.0 Lg	998 9.2 L	990 6.0 Ht	999 8.0 Jo
989 9.9 L	985[12.4 GC	000 8.0 Lg	006 10.4 B	992 6.1 Dr	000 8.4 Ya
001 10.3 Pt	989[12.7 B	000 7.9 Ya	014 9.4 L	993 6.0 En	001 7.8 Pt
006 10.8 B	R Cnc	001 7.8 Pt	019 9.5 Wa	994 5.6 Dr	002 8.9 Cb
006 10.4 Ch	081112	001 8 0 Lg	RW Car	997 5.7 Dr	006 8.6 Ch
024 10.8 Pt	970 7.5 Ch	006 7.7 Ch	*091868*	997 5.6 Ht	007 8.5 Jo
T CMi	976 7.4 L	011 8.0 B	943 11.4 En	998 6.5 En	010 8.1 Wa
072811	986 6.9 Ch	020 8.4 Pt	947 11.2 Bl	999 5.5 Dr	011 8.5 B
987 10.1 B	993 7.2 L	T Hya	963 12.5 Bl	000 5.5 Bl	016 8.7 Wa
000 10.8 B	994 7.1 Ch	*085008*	965 12.4 En	X Hya	018 8.9 Wa
001 10.0 Pt	998 7.0 L	971 8.7 Ch	Y Vel	*093014*	018 8.8 Jo
024 10.4 Pt	000 7.7 Ya	976 9.0 L	*092551*	946 11.7 Bg	019 8.8 Wa
S Vol	001 7.7 Pt	977 9.0 Ch	944 12.0 En	955 12.0 Bg	020 8.6 Pt
073173	006 7.4 Ch	989 9.5 B	945 12.4 Sm	961 12.3 Bg	021 8.7 Wa
945 10.0 En	006 7.4 B	994 9.7 Ch	947 11.9 Bl	971 12.8 Bf	022 8.8 Wa
947 10.4 Bl	014 7.5 L	996 9.9 Ya	963 12 3 Bl	993 13.0 Bg	023 8.8 Sg
961 9.5 En	016 7.5 Wa	998 9.7 L	965 12.0 En	996 13 0 Bf	024 8.8 Wa
963 9.3 Bl	020 8.3 Pt	001 9.7 Pt	969 12.4 Sm	998 12.9 B	027 8.7 Wa
965 9.5 En	022 7.6 Wa	011 10.0 B	975 12.8 Sm	001 13.0 Pt	028 9.3 Ya
967 9.4 Bl	V Cnc	020 10.6 Pt	978 12.4 En	020 13.0 Pt	029 9 0 Jo
975 9.3 Bl	081617	T Cnc	993 12.4 En	Y Dra	032 9.4 Cb
985 9.4 Bl	970 7.8 Ch	085120	999 12.6 En	093178	033 9.1 Wa
999 9.8 Bl	990 8 0 B	922 8.7 Fr	R Car	994 10.1 Ch	033 9.2 Jo
U CMi	994 8.3 Ch	924 8.7 Fr	*093962*	028 11.7 Ie	Y Hya
073508	001 7.8 Pt	928 8.7 Fr	943 8.0 En	R LMi	*094622*
976 9.7 L	006 8.0 Ch	929 8.7 Fr	945 7.6 Sm	093934	001 6.3 Pt
989 9.6 L	007 8.4 B	932 8.8 Fr	945 8.0 Ht	971 8.7 Ch	Z Vel
000 9.6 B	020 8.0 Pt	933 8 8 Fr	947 7.0 Bl	977 7.7 Ch	*094953*
001 9.7 Pt		940 8.8 Fr	947 7.6 En	979 7.5 L	945 12.1 Sm
016 9.7 L		942 8.8 Fr	950 7.6 Dr	992 7.0 Ch	945 12.6 Ht

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Z VEL	S CAR	U HYA	W LEO	SU VIR	U CEN
094953	*100661*	*103212*	104814	120012	*122854*
947 12.6 Bl	963 7.3 Bl	988 5.9 Kd	027 10.5 Wa	967 10.2 Ch	947 8.6 Bl
951 12.3 Ht	964 7.9 Dr	989 4.7 L	RS CAR	992 9.7 B	963 8.0 Bl
952 12.3 Sm	965 7.8 Dr	995 5.7 Kd	*110361*	995 9.6 Ch	967 8.0 Bl
959 12.2 Ht	965 7.8 Ht	000 5.9 Kd	943[12.1 En	001 9.5 Pt	975 8.1 Bl
963 11.7 Bl	965 7.5 En	000 4.6 L	947[12.1 En	010 9.4 Wa	985 8.0 Bl
965 12.2 Ht	967 7.6 Bl	008 5.7 Go	969[12.3 Sm	017 10.3 B	000 8.4 Bl
965 12.0 En	969 8.2 Sm	011 5.7 Go	978[12.1 En	019 10.0 Wa	R UMA
967 11.9 Bl	969 8.0 Dr	020 5.2 Be	999[12.1 En	021 10.2 Wa	123160
969 11.4 Sm	970 8.2 Ht	026 4.9 Be	S LEO	024 10.9 Pt	907 9.0 Wb
970 12.1 Ht	974 8.3 Dr	026 4.8 L	110506	T VIR	921 10.0 Wb
975 11.8 Sm	975 8.4 Dr	R UMA	961 12.6 Ch	*120905*	967 12.5 Ch
975 11.1 Bl	975 7.9 Bl	103769	995 11.5 Ch	001 10.2 Pt	991 12.3 Cd
976 11.4 En	975 8.5 Sm	973 11.5 Ch	996 11.6 Ie	002 10.8 Rh	994[10.8 Sg
985 10.6 Ht	976 8.0 En	991 10.8 Ch	001 11.6 Pt	024 11.2 Pt	001 12.7 Pt
985 10.6 Bl	978 8.5 Dr	993 11.0 Gs	022 11.0 Eb	R CRV	020 12.0 Al
990 10.3 Ht	981 8.5 Dr	000 11.0 Ch	022 10.7 Kz	*121418*	024 12.8 Pt
993 9.8 En	981 8.7 En	001 10.8 Pt	024 11.2 Pt	945 11.8 Bf	033[12.3 Kz
997 9.8 Ht	982 8.6 Dr	005 10.7 B	027 10.9 Wa	954 11.3 Bf	R VIR
998 9.1 En	984 8.6 Dr	007 10.8 Cd	033 11.4 Wa	968 10.2 Bf	123307
000 9.0 Bl	984 9.1 En	020 9.3 Pt	RY CAR	979 8.9 L	963 7.5 Ch
V LEO	985 8.4 Bl	025 8.5 Gs	*111561*	984 9.4 Bf	976 7.7 L
095421	985 9.0 Ht	031 8.2 Gs	947 12.5 Bl	989 8.5 L	979 7.9 L
971 10.6 Ch	987 8.8 Dr	043 7.3 Eb	964 13.0 Bl	994 8.5 Mj	992 8.5 B
989 11.5 Ch	988 8.6 Dr	043 7.4 Kz	975 13.4 Bl	001 8.3 Pt	997 8.4 Ch
991 11.9 Cl	992 8.8 Dr	V HYA	RS CAR	006 8.2 B	001 8.8 Pt
993 12.1 Sg	993 8.0 En	*104620*	*111661*	010 8.8 Wa	001 8.5 Ch
994 11.9 Ch	994 8.6 Dr	947 8.5 Bl	940 12.1 Sm	021 8.0 Wa	024 10.4 Pt
000 12.2 Cl	997 8.1 Dr	963 8.5 Bl	947 13.5 Bl	024 8.1 Pt	029 10.8 L
001 12.0 Pt	997 8.0 En	967 8.5 Bl	964[13.1 Bl	026 8.1 L	029 10.2 Ya
005 12.0 B	997 8.0 Ht	970 9.2 Ch	969[12.7 Sm	029 8.1 Ya	RS UMA
020 12.0 Pt	999 8.0 Dr	975 8.5 Bl	975 13.0 Bl	SS VIR	123459
023[12.4 Sg	999 7.7 En	977 9.1 Ch	X CEN	122001	945 13.4 Bf
RV CAR	000 7.8 Bl	979 8.0 L	*114441*	976 8.4 L	954 12.9 Bf
095563	Z CAR	985 8.5 Bl	947 10.2 Bl	989 8.6 L	965 11.6 Ch
947 13.6 Bl	*101058*	994 8.9 Ch	964 8.3 Bl	990 9.0 B	968 11.3 Bf
963 11.9 Bl	943[12.3 En	998 8.8 Ch	967 8.2 Bl	008 8.8 B	976 10.9 Ch
967 11.2 Bl	965[12.3 En	000 7.9 L	975 8.2 Bl	026 7.6 L	984 9.5 Bf
975 11.5 Bl	975[12.3 Sm	000 8.6 Ya	986 8.1 Bl	T CVN	989 9.0 Ch
985 11.4 Bl	994[12.3 En	000 8.4 Bl	000 8.4 Bl	122532	991 8.7 Al
000 12.0 Bl	W VEL	000 8.8 Ch	W CEN	993 10.0 Gs	991 8.5 Cd
RY LEO	*101153*	001 8.1 Pt	*115058*	999 9.3 Cl	991 8.8 Ch
095814	945 9.7 Sm	006 8.8 Ch	944[12.6 En	001 8.8 Pt	994 8.8 Sg
989 9.5 Kl	947 9.4 Bl	024 7.2 Pt	964 13.5 Bl	021 9.7 Wa	995 8.5 Jo
995 9.8 Kl	952 9.8 Sm	029 7.7 L	981[12.2 En	024 9.5 Pt	996 9.1 Bf
999 9.7 Kl	963 9.7 Bl	029 8.5 Ya	994[12.6 En	025 10.0 Gs	999 8.3 Jo
002 9.9 Kl	967 9.9 Bl	RS HYA	R COM	029 9.7 Ya	000 8.6 Ch
S CAR	969 9.8 Sm	*104628*	115919	033 9.9 Kz	001 8.2 Pt
100661	975 10.2 Sm	975 12.1 Bl	967 12.1 Ch	043 9.4 Kz	002 8.5 Cb
943 6.3 En	975 10.7 Bl	985 11.7 Bl	991 9.1 Cl	043 9.8 Eb	008 8.3 Cd
945 6.2 Sm	985 10.9 Bl	000 10.6 Bl	995 8.7 Ch	Y VIR	008 8.3 Io
945 6.2 Ht	000 10.9 Bl	W LEO	996 8.7 Ie	*122803*	017 9.8 B
947 6.6 En	U HYA	104814	001 8.6 Pt	945 15.0 Bf	020 8.3 Al
947 6.0 Bl	*103212*	945 13.8 Bf	002 9.0 Rh	954 14.8 Bf	022 8.1 Wa
951 6.8 Ht	919 6.0 Kd	954 13.7 Bf	007 8.6 Cd	968 14.9 Bf	024 8.1 Pt
952 6.5 Sm	936 5.9 Kd	968 13.7 Bf	018 8.6 Wa	973[13.2 Ch	027 8.3 Wa
953 6.8 En	939 6.1 Kd	971 13.5 Bf	021 8.6 Wa	993 14.6 Bg	029 8.3 Jo
959 7.7 Ht	947 5.9 Kd	996 12.4 Bf	024 8.5 Pt	994[12.8 GC	029 8.6 Ya
961 7.3 En	960 6.0 Kd	001 12.0 Pt	029 8.9 Ya	002 14.0 Rh	032 8.8 Cb
962 7.8 Dr	979 5.0 L	004 11.5 B		021[11.1 Wa	033 8.3 Io
963 7.8 Dr	988 5.9 Kd	024 10.0 Pt		026 11.8 L	044 8.8 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S UMa	U Oct	S Vir	T Cen	Z Vir	S Boo
123961	*131283*	*132706*	*133633*	*140512*	141954
907 8.2 Wb	951 9.4 Ht	996 6.8 Sm	986 6.3 Bl	999[13.3 GC	001 11.5 Pt
921 8.0 Wb	952 9.4 Sm	997 6.9 Lg	990 6.8 Ht	RU Hya	006 12.6 Ch
965 8.4 Ch	959 9.6 Ht	999 6.9 Lg	992 7.1 Dr	*140528*	018 12.3 B
977 9.0 Jn	963 10.1 Bl	000 6.9 Lg	994 7.4 Dr	943 10.4 En	023 12.5 Sg
979 8.2 L	965 10.5 Ht	001 6.8 Lg	994 7.1 En	945 10.5 Sm	026 12.4 Pt
986 8.9 Ch	967 10.2 Bl	001 6.5 Wb	995 7.0 Kd	947 10.6 Bl	029 12.5 L
989 8.7 L	969 10.5 Sm	001 6.7 Pt	996 7.4 Sm	964 10.8 Bl	RS Vir
991 8.8 Al	970 10.7 Ht	002 7.6 Cb	997 7.9 Ht	965 11.4 En	142204
991 9.1 Cd	976 10.9 Bl	006 6.6 Ch	997 7.6 Dr	968 10.8 Bl	028 13.4 B
991 9.0 Ch	985 11.4 Bl	008 7.0 B	999 7.6 Dr	969 11.4 Sm	V Boo
992 9.2 Gz	991 11.9 Ht	016 7.0 Sg	999 7.8 En	972 12.0 En	142539a
993 9.2 Gz	997 12.4 Ht	017 6.9 Lg	000 7.6 Bl	976 11.1 Bl	963 7.0 Ch
993 9.0 Wb	000 12.6 Bl	023 6.9 Lg	000 7.2 Kd	980 12.2 En	979 7.1 L
994 8.5 Sg	W Vir	024 6.6 Sg	001 8.0 Ht	986 11.6 Bl	986 7.4 Ch
995 8.9 Jo	*132002*	024 7.0 Pt	RT Cen	994 12.3 En	989 7.3 L
999 9.1 Jo	990 9.2 B	026 7.2 Wb	*134236*	996 12.2 Sm	992 7.8 Sg
001 9.4 Pt	008 9.8 B	028 7.3 Ya	944 9.4 En	999 12.2 En	993 7.6 Gb
005 9.4 Gz	033 10.0 Ya	032 6.9 Cb	947 9.1 Bl	000 12.5 Bl	994 7.6 Mj
006 10.0 Jn	V Vir	RV Cen	963 9.1 Bl	R Cen	995 7.5 Jo
008 9.3 Jo	*132202*	*133155*	967 9.2 Bl	*140059*	998 7.7 Ch
008 9.9 Cd	990 8.5 B	947 7.2 Bl	976 9.4 Bl	941 8.9 Sm	999 7.7 Jo
010 9.0 Wa	008 9.6 B	963 7.5 Bl	980 9.6 En	943 9.2 En	001 7.8 Pt
018 10.0 Wa	033 10.0 Ya	967 7.5 Bl	986 9.3 Bl	945 9.2 Ht	003 8.0 Sg
020 9.8 Al	R Hya	976 7.5 Bl	994 9.4 En	947 9.5 Bl	008 7.9 Jo
021 10.5 Sg	*132422*	986 7.4 Bl	000 10.0 Bl	947 9.0 Sm	018 8.7 B
024 10.8 Pt	941 8.7 Sm	000 7.6 Bl	R CVn	947 9.2 En	020 8.8 Sg
026 10.9 Wb	944 8.8 En	T UMi	134440	951 9.7 Ht	022 9.0 Eb
027 10.7 Wa	947 8.5 Sm	133273	964 11.5 Ch	952 9.2 Sm	022 8.8 Kz
029 10.6 Ya	947 8.9 Bl	004[13.6 B	998 10.5 Ch	953 9.7 En	026 8.8 Pt
029 10.9 Be	963 9.1 Ch	T Cen	001 10.2 Pt	961 9.9 En	027 9.0 L
029 10.3 Jo	963 8.9 Bl	*133633*	002 9.8 Cb	964 9.6 Bl	029 9.0 Jo
029 10.9 L	965 8.7 En	941 6.9 Sm	005 9.8 B	965 10.3 Ht	033 9.3 Ya
033 10.7 Jo	967 8.8 Bl	943 6.8 En	018 8.8 Ie	965 9.9 En	036 9.2 Jo
033 11.2 Kz	969 8.3 Sm	945 6.5 Sm	022 8.8 Eb	968 9.5 Bl	039 9.4 Gb
Y CVn	972 8.7 En	945 6.5 Ht	022 8.5 Kz	970 10.4 Ht	R Cam
124045	976 8.8 Bl	947 6.8 En	026 8.6 Pt	976 10.2 Bl	142584
008 5.6 Go	978 8.9 Ch	947 6.0 Bl	028 8.7 Ya	978 10.0 En	002 13.2 B
011 5.6 Go	979 8.0 L	951 6.5 Ht	031 10.0 Gs	985 10.3 Ht	028 12.6 B
RU Vir	980 8.5 En	952 6.4 Sm	043 8.6 Eb	986 10.1 Bl	R Boo
124204	986 8.0 Bl	953 6.5 En	043 8.6 Kz	990 10.6 Ht	143227
992 12.0 B	989 7.6 L	963 6.0 Bl	RX Cen	994 10.3 En	976 11.7 Ch
993 12.0 GC	989 8.4 Ch	964 6.2 Dr	*134536*	996 10.5 Sm	994 11.2 GC
001 12.6 Pt	994 7.4 En	965 6.2 Ht	964[13.1 Bl	997 10.7 Ht	998 10.0 Ch
008 11.8 B	996 7.5 Sm	965 6.8 En	T Aps	999 10.3 En	001 9.8 Pt
021 12.2 Ie	999 7.3 En	967 5.8 Bl	*134677*	000 10.1 Bl	006 9.9 B
024 12.4 Pt	000 7.2 Bl	969 6.2 Dr	941 10.2 Sm	U UMi	026 8.8 Pt
U Vir	001 6.9 Pt	969 6.1 Sm	947 10.4 Sm	141567	029 8.6 Sg
124606	006 7.0 Ch	970 6.5 Ht	947 10.2 Bl	921 10.5 Wb	031 8.8 Cb
992 11.0 B	024 6.5 Pt	972 6.3 En	952 10.8 Sm	963 11.3 Ch	033 8.6 Ya
001 12.0 Pt	026 6.5 L	973 6.4 Ht	964 11.2 Bl	973 11.5 Ch	051 7.2 Cb
008 12.5 B	028 7.0 Ya	974 6.2 Dr	968 11.3 Bl	001 12.6 Pt	053 8.0 Rw
024 12.1 Pt	S Vir	975 6.3 Dr	969 12.0 Sm	002 12.3 B	V Lib
RV Vir	*132706*	976 6.0 Bl	976 12.0 Bl	026 12.1 B	*143417*
130212	941 10.8 Sm	978 6.0 Dr	RR Vir	026 12.5 Pt	999 12.6 GC
000[13.8 B	947 11.5 Sm	980 6.3 Eb	*135008*	S Boo	000 13.0 B
U Oct	963 9.8 Ch	981 6.2 Dr	001 13.7 Pt	141954	U Boo
131283	969 9.0 Sm	982 6.4 Dr	026 14.0 Pt	972 10.0 Ch	144918
945 9.4 Sm	978 8.2 Ch	984 6.5 En	Z Vir	979 10.5 L	025 11.8 B
945 9.2 Ht	992 7.6 B	984 6.3 Dr	*140512*	989 11.4 L	
947 9.5 Bl	993 7.3 Ch	985 6.7 Ht	998[13.3 GC	994 11.0 Sg	

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Y LUP	S CRB	R NOR	Z LIB	R CRB	V CRB
145254	151731	*152849*	*154020*	154428	154639
941[12.4 Sm	999 10.9 Cl	992 10.1 Dr	968[12.7 Bl	016 6.2 Sg	026 10.5 Pt
947[12.4 Sm	001 10.5 Sg	994 10.2 Dr	R CRB	017 6.1 Pt	RR LIB
964 13.4 Bl	001 10.8 Pt	994 10.3 En	154428	018 6.2 Sg	*155018*
969[12.8 Sm	003 11.2 Sg	996 10.0 Sm	921 6.0 Wb	020 6.1 Pt	971 9.8 Ch
976[13.7 Bl	004 10.7 B	997 10.6 Dr	923 6.2 Kd	020 6.0 Be	981 10.8 L
996[12.4 Sm	022 11.2 Eb	999 10.8 Dr	951 6.2 Kd	020 6.2 Sg	995 12.0 Ch
S APS	022 11.0 Kz	999 10.6 En	964 6.9 Ch	021 6.1 Pt	001 12.1 L
145971	026 12.0 Pt	000 10.2 Bl	967 5.9 Ch	022 6.1 Pt	001 11.7 Pt
944 10.0 En	027 11.8 B	X LIB	971 6.0 Ch	022 6.0 Eb	020 13.1 L
945 9.9 Sm	RS LIB	*153020*	975 6.0 Ch	022 5.9 Kz	026 13.6 Pt
947 10.1 Bl	*151822*	953 11.7 Bl	976 6.1 L	023 6.2 Sg	Z CRB
952 9.9 Sm	945 8.6 Ht	964 11.1 Bl	978 6.1 Ch	024 6.2 Sg	155229
953 9.9 En	953 8.3 Bl	968 10.8 Bl	981 6.1 L	024 6.0 Pt	004 11.3 B
952 9.9 Sm	964 8.2 Bl	976 10.4 Bl	983 6.1 L	024 6.0 L	025 12.6 B
953 9.9 En	965 8.9 En	000 10.2 Bl	989 8.3 Kl	026 6.1 Pt	RZ Sco
954 10.1 Bl	968 8.6 Bl	W LIB	991 6.1 Cd	026 6.0 Be	*155823*
964 10.1 Bl	972 8.6 Sm	*153215*	991 6.2 Cl	027 6.1 Pt	945 12.4 Ht
968 10.0 Bl	973 8.9 Ht	968[13.5 Bl	992 6.3 Gz	027 6.1 L	973 12.4 Ht
968 10.0 En	976 8.8 Bl	981[13.1 L	992 6.2 Sg	027 6.2 Sg	994 12.1 En
969 9.9 Sm	978 9.1 En	029[11.0 Sg	993 6.2 Sg	029 6.0 Be	997 11.6 Ht
976 10.1 Bl	981 8.9 L	S UMI	993 6.0 Gb	029 6.0 Jo	000 11.3 En
986 10.0 Bl	984 9.8 En	153378	993 5.9 Ch	030 6.1 L	001 11.0 Pt
000 10.0 Bl	985 9.2 Ht	963 9.6 Ch	993 6.4 Gz	031 6.1 Cl	026 9.0 Pt
T LIB	986 8.8 Bl	993 10.5 Ch	995 6.5 Kl	032 6.1 Pt	X HER
150510	994 9.9 En	001 10.1 Pt	995 6.0 Jo	032 6.2 L	155947
005 13.0 B	996 10.2 Sm	024 11.2 Sh	995 6.0 Kd	032 6.0 Cb	008 6.3 Go
Y LIB	997 9.5 Ht	026 10.8 Pt	996 6.2 Ch	032 6.0 Be	011 6.3 Go
150605	999 10.0 L	026 10.5 B	998 6.5 Cb	033 6.1 Pt	012 6.4 Go
973 8.6 L	000 9.9 Bl	U LIB	999 6.2 Sg	033 6.0 Jo	Z SCO
983 8.5 L	006 10.0 B	*153620a*	999 6.0 L	033 6.0 Cb	*160021*
001 8.7 Pt	029 11.2 L	968[13.1 Bl	999 6.0 Jo	033 6.0 Ya	968 11.9 Bl
018 8.9 B	RU LIB	996[13.1 GC	999 6.1 Pt	036 6.1 Pt	972 11.9 L
020 9.2 L	*152714*	999[13.1 GC	999 6.5 Cl	036 6.0 Cb	973 12.0 Ht
026 9.5 Pt	001 13.6 Pt	T NOR	000 6.4 Kd	037 6.1 Pt	983 11.9 L
033 9.5 Ya	005 13.0 B	*153654*	000 6.1 L	038 6.1 Pt	997[12.0 Ht
S LIB	026 12.5 Pt	941 7.5 Sm	001 6.2 Sg	039 6.1 Pt	000[12.2 Bl
151520	029 12.6 L	945 8.2 Ht	001 6.1 Pt	040 6.0 Pt	029 12.3 L
971 10.5 Ch	R NOR	947 7.8 Sm	001 6.2 Cb	041 6.1 Pt	R HER
981 10.2 L	*152849*	965 8.3 Ht	002 6.2 Sg	042 6.1 Pt	160118
995 11.0 Ch	941 7.5 Sm	965 8.0 Dr	002 6.5 Kl	044 6.2 Pt	992[12.4 Sg
999 11.4 L	947 8.0 Sm	969 8.4 Dr	002 6.0 Gb	044 6.1 Jo	002 13.7 Rh
001 11.9 Pt	947 7.7 Bl	969 7.9 Sm	002 6.1 Pt	046 6.1 Pt	006[13.3 B
026 12.8 Pt	964 8.5 Bl	970 8.6 Ht	002 6.1 L	051 5.9 Cb	026 13.2 Pt
029 11.2 L	964 9.0 Dr	974 8.7 Dr	002 6.3 Cb	X CRB	027 13.0 B
S SER	965 9.0 Dr	975 8.7 Dr	003 6.2 Sg	154536	U SER
151714	965 9.9 En	978 8.5 Dr	003 6.1 Pt	004[13.4 B	160210
973 14.0 L	968 8.9 Bl	981 8.9 Dr	003 6.0 Be	R SER	001 10.9 Pt
996 12.9 GC	969 8.9 Sm	982 8.4 Dr	004 6.2 Ch	154615	003 10.0 Sg
001 13.5 Pt	969 9.3 Dr	984 8.4 Dr	005 6.3 Gz	963 8.1 Ch	011 10.6 B
002 13.7 Rh	974 9.7 Dr	985 8.9 Ht	005 6.1 Pt	977 8.5 Ch	023 11.5 Sg
005 13.2 B	975 9.6 Dr	987 9.2 Dr	005 6.0 Cb	993 8.9 Ch	026 11.5 Pt
026 13.0 Pt	976 9.3 Bl	991 9.9 Ht	006 6.0 Be	001 9.4 Pt	S SCO
029 12.5 L	978 9.4 En	992 9.5 Dr	007 6.3 Kl	008 9.6 B	*160221a*
S CRB	978 9.6 Dr	994 9.5 Dr	008 6.1 Ch	026 10.4 Pt	968 13.0 Bl
151731	981 9.7 Dr	997 9.8 Dr	008 6.3 B	029 11.0 Sg	SX HER
963 9.9 Ch	982 9.7 Dr	997 10.1 Ht	008 5.8 Go	V CRB	160325
977 10.1 Ch	984 9.8 Dr	999 10.0 Dr	008 6.0 Jo	154639	972 7.7 L
992 10.8 Sg	986 9.4 Bl		009 6.1 Pt	001 11.0 Pt	983 8.0 L
993 10.7 Ch	987 9.9 Dr		013 6.1 Pt	018 9.9 B	999 8.1 Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
SX HER	R SCO	T OPH	RS SCO	RS HER	U ARA
160325	*161122a*	*162815*	*164844*	171723	*174551*
001 8.1 Pt	026 11.6 Pt	000 9.2 Bl	967 10.3 Ht	001 10.1 Pt	000 9.2 En
002 8.0 Pt	S SCO	001 10.1 L	968 9.4 Bl	021 12.0 Wa	T DRA
002 8.2 L	*161122b*	001 9.1 Pt	969 9.4 Sm	025 12.1 B	175458a
005 7.9 Pt	945 12.2 Ht	026 10.9 Pt	973 10.5 Ht	026 12.2 Pt	002 11.2 Rh
009 8.1 Pt	945 12.5 Bf	S OCT	976 10.0 Bl	S OCT	004 11.0 Cd
011 8.0 Pt	954 13.1 Bf	*162816*	984 10.4 En	*172486*	026 10.7 B
013 8.4 Pt	968 13.4 Bl	968 10.4 Bl	986 10.2 Bl	944 7.1 En	UY DRA
017 8.6 Pt	968 13.6 Bf	973 10.4 L	994 10.4 En	945 8.1 Sm	175458b
020 8.8 Pt	972[12.2 Sm	000 10.3 Bl	996 11.2 Sm	945 7.6 Ht	002 11.9 Rh
020 8.8 L	978[12.4 En	001 10.3 L	997 11.3 Ht	947 6.8 Bl	004 11.2 Cd
021 8.9 Pt	984 14.2 Bf	030 11.3 L	000 10.7 Bl	951 7.6 Ht	026 11.0 B
022 8.6 Pt	997 14.5 Bf	W HER	000 11.2 En	959 7.8 Ht	RY HER
024 8.6 Pt	997 12.4 Ht	163137	RR SCO	965 8.3 Ht	175519
026 8.8 Pt	000[13.0 Bl	001 13.0 Pt	*165030*	968 7.7 Bl	994 11.9 Ch
027 8.6 Pt	001 14.5 Bf	002 12.8 Rh	968 9.6 Bl	968 8.3 En	001 11.7 Pt
032 8.6 Pt	W CRB	005 13.1 B	969 9.3 Dr	969 8.6 Sm	002 11.7 Rh
032 9.0 L	161138	026 13.6 Pt	975 9.1 Dr	970 8.6 Ht	004 11.6 Ch
033 8.6 Pt	007 12.9 Cd	027 13.4 B	978 8.9 Dr	976 8.3 Bl	026 9.6 Pt
036 8.8 Pt	011 13.4 Pt	R UMI	981 9.0 Dr	978 8.6 En	V DRA
037 8.8 Pt	025 12.7 B	163172	982 9.0 Dr	981 9.1 En	175654
038 8.7 Pt	W OPH	017 9.9 B	984 8.7 Dr	985 9.7 Ht	001 10.2 Pt
039 8.8 Pt	*161607*	R DRA	992 8.7 Dr	986 9.2 Bl	004 10.5 Cd
040 8.8 Pt	973 14.0 L	163266	994 8.4 Dr	991 9.9 Ht	026 11.6 Pt
041 8.6 Pt	995[11.8 Ch	001 13.0 Pt	997 8.2 Dr	993 9.8 En	R PAV
042 8.4 Pt	V OPH	005 12.0 B	999 8.3 Dr	997 10.3 Ht	*180363*
044 8.3 Pt	162112	021 11.5 Wa	000 7.8 Bl	998 9.8 En	945 10.4 Ht
046 8.2 Pt	977 10.7 Ch	026 11.8 Pt	SS OPH	000 9.8 Bl	967 8.3 Ht
W SCO	001 8.7 Pt	029 11.0 Jo	*165302*	RU OPH	969 8.0 Sm
160519	026 8.0 Pt	033 10.6 Jo	026 9.4 Pt	172809	973 7.8 Ht
968[13.0 Bl	U HER	044 10.0 Jo	RV HER	001 12.2 Pt	997 7.8 Ht
RU HER	162119	050 9.4 Jo	165631	002 12.1 Rh	T HER
160625	992 11.3 Sg	g HER	001 13.1 Pt	021 10.8 Wa	180531
963 9.3 Ch	994 11.7 Ch	163740	002 12.9 Rh	026 11.1 Pt	981 9.8 L
972 8.7 L	001 12.0 Pt	000 4.6 Go	005 12.6 B	RT SER	001 8.2 Pt
977 9.6 Ch	003 11.2 Sg	008 4.7 Go	024 11.0 Sg	*173212*	003 7.8 Jo
983 9.4 L	003 11.0 Jo	011 4.9 Go	026 11.0 Pt	030 12.3 L	008 7.9 Jo
995 10.5 Ch	004 11.4 B	RR OPH	028 11.9 B	RU SCO	020 8.8 Sg
001 10.1 Pt	008 10.9 Jo	*164319*	029 10.9 Jo	*173543*	020 8.4 L
002 10.2 Rh	023 11.3 Sg	945 14.0 Bf	033 11.0 Jo	968 12.8 Bl	021 8.1 Wa
002 10.2 L	026 11.6 Pt	954 13.4 Bf	RT SCO	000 11.5 Bl	026 8.3 Pt
008 10.8 Cl	027 11.1 B	968 11.7 Bf	*165636*	SV SCO	028 8.3 Wa
020 10.6 L	029 10.8 Jo	983 11.3 L	968 10.4 Bl	*174135*	029 9.0 Jo
026 10.6 Pt	036 10.7 Jo	984 11.4 Bf	000 11.9 Bl	968 10.3 Bl	032 8.8 Cb
R SCO	Y SCO	995 11.0 En	003 12.5 Sg	000 9.6 Bl	036 8.7 Jo
161122a	*162319*	997 10.7 Bf	R OPH	W PAV	051 9.5 Cb
945 13.9 Bf	981[13.5 L	001 10.6 Bf	*170215*	*174162*	W DRA
954 13.8 Bf	029 13.2 L	001 10.1 Pt	994 11.6 Ch	945[12.3 Ht	180565
968 12.0 Bf	SS HER	021 8.7 Wa	RT HER	968[13.0 Bl	004 12.0 Cd
968 12.2 Bl	162807	026 8.3 Pt	170627	969[12.3 Sm	021 10.2 Wa
972 11.7 Sm	981 11.6 L	030 8.4 L	002 14.5 Rh	973[13.0 Ht	026 9.8 Pt
973 11.7 Ht	001 11.5 L	S HER	RW SCO	997[13.0 Ht	X DRA
978 11.0 En	001 11.9 Pt	164715	*170833*	000[13.0 Bl	180666
984 10.8 Bf	006 11.2 B	995 9.8 Ch	968[12.5 Bl	RS OPH	004 13.5 Cd
994 10.2 En	025 10.0 B	001 10.0 Pt	000[13.0 Bl	174406	Nov OPH
997 10.4 Bf	026 9.9 Pt	018 10.0 B	Z OPH	001 11.1 Pt	180911
997 10.1 Ht	026 10.3 L	021 10.5 Wa	171401	026 11.1 Pt	001[13.0 Pt
000 10.6 En	T OPH	026 10.0 Pt	001 11.5 Pt	U ARA	026[13.3 Pt
000 9.9 Bl	*162815*	RS SCO	026 11.9 Pt	*174551*	TV HER
001 10.0 Pt	968 9.1 Bl	*164844*		972 9.7 Sm	181031
001 10.3 Bf	973 8.7 L	945 9.1 Ht		997 9.0 En	081[14.0 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RY OPH	R SCT	V LYR	RY SGR	R CYG	RU SGR
181103	*184205*	190529a	*191033*	193449	*195142*
001 11.4 Pt	033 5.9 Pt	002 13.4 Rh	997 7.2 Dr	029 9.9 Jo	968 11.8 Bl
026 8.1 Pt	033 5.7 Jo	026 10.2 Pt	999 7.1 Dr	032 10.3 Pt	NOV CYG
W LYR	036 6.0 Pt	RX SGR	999 7.1 Pt	033 10.0 Jo	195553
181136	037 5.8 Pt	*190818*	000 6.6 Bg	044 10.2 Jo	999[12.2 Pt
981 7.9 L	038 5.7 Pt	001[11.1 Ch	000 7.3 Bl	S PAV	020[12.2 Pt
995 8.3 Jo	039 5.7 Pt	RW SGR	001 7.3 L	*193072*	026[12.2 Pt
999 8.1 Jo	039 5.8 Gb	*190819a*	001 6.7 Pt	945 12.6 Ht	037[12.2 Pt
001 8.0 Pt	040 5.6 Pt	975 9.6 Ch	001 7.4 Ch	968 10.4 Bl	Z CYG
008 8.0 Jo	041 5.4 Pt	001 10.3 Pt	013 6.4 Pt	969 11.2 Sm	195849
022 8.5 L	042 5.4 Pt	001 10.4 Ch	020 6.3 L	973 10.5 Ht	994 11.1 Ch
023 8.3 Gb	044 5.3 Pt	026 11.2 Pt	025 6.5 L	976 10.0 Bl	001 9.4 Pt
024 8.6 Sg	044 5.9 Jo	TY AQL	031 6.5 L	986 7.9 Bl	033 8.2 Pt
026 9.0 Pt	046 5.2 Pt	*190007*	036 6.7 Pt	997 7.4 Ht	S TEL
029 8.6 Jo	051 5.6 Cb	001 10.3 Pt	037 6.8 Pt	000 7.7 Bl	*195855*
036 8.0 Jo	NOV AQL	026 10.2 Pt	038 6.8 Pt	RT CYG	968[12.6 Bl
A HER	184300	S LYR	039 7.4 Pt	194048	000 13.0 Bl
181522	975 10.5 Ch	190925	040 7.5 Pt	975 7.5 Ch	SY AQL
008 6.2 Go	998 10.4 Ch	001 12.7 Pt	TV SGR	994 7.2 Ch	200212
011 6.2 Go	999 11.2 Pt	026 13.2 Pt	*191124*	001 7.1 Pt	983 13.0 L
012 6.4 Go	001 11.4 Pt	X LYR	968[12.4 Bl	003 7.7 Jo	001 12.1 Pt
RV SGR	013 11.2 Pt	190926	000[13.0 Bl	008 7.5 Jo	031 14.1 L
182133	026 11.6 Pt	001 8.6 Pt	S SGR	021 8.5 Sg	033 12.5 Pt
968 13.2 Bl	032 11.5 Pt	026 8.9 Pt	*191319a*	028 8.7 Wa	S CYG
000[13.6 Bl	037 11.4 Pt	RS LYR	968 12.6 Bl	032 8.7 Pt	200357
SV HER	040 11 3 Pt	190933a	000 10.6 Bl	033 8.5 Jo	001 13.2 Pt
182224	RX LYR	996[11.8 Ch	001 10.4 Pt	TU CYG	024 10.5 Sg
983 13.6 L	185032	U DRA	032 10.6 Pt	194348	033 10.2 Pt
002 14.6 Rh	975 12.0 Ch	190967	SW SGR	994 9.3 Ch	R CAP
031 13.9 L	995[11.9 Ch	975 9.8 Ch	*191331*	001 9.0 Pt	*200514*
RV LYR	S CRA	995 10.0 Ch	968 13.0 Bl	032 9.4 Pt	001 12.5 Pt
184134	*185437a*	001 10.0 Pt	000 12.1 Bl	X AQL	033 12.6 Pt
002 14.8 Rh	968 11.5 Bl	032 11.0 Pt	TZ CYG	194604	S AQL
021[11.7 Wa	000 11.6 Bl	W AQL	191350	001 14.6 Pt	200715a
R SCT	ST SGR	*191007*	001 10.1 Pt	002 14.4 Rh	977 9.4 Ch
184205	*185512a*	975 10.5 Ch	032 10.7 Pt	χ CYG	001 10.5 Pt
923 5.4 Kd	001 11.3 Ch	001 10.9 Ch	U LYR	194632	033 11.0 Pt
951 5.5 Kd	031 10.3 L	001 11.1 Pt	191637	923 7.5 Kd	RW AQL
972 5.0 L	R CRA	026 11.3 Pt	001 11.1 Pt	967 6.0 Ch	200715b
975 5.8 Ch	*185537a*	T SGR	032 10.5 Pt	967 6.1 Ch	001 9 3 Pt
981 5.1 L	968 12.8 Bl	*191017*	TY CYG	971 6.0 Ch	033 9.3 Pt
998 5.9 Ch	000 12.0 Bl	001 12.5 Pt	192928	975 6.1 Ch	R TEL
999 5.9 Pt	T CRA	032 12.0 Pt	002 11.8 Rh	977 6.1 Ch	*200747*
000 5.8 Kd	*185537b*	R SGR	032 11.6 Pt	978 6.1 Ch	968[13.0 Bl
001 5.8 L	968[13.0 Bl	*191019*	RT AQL	981 6.1 L	W CAP
001 5.9 Pt	000[13.0 Bl	001 11.7 Pt	193311	984 6.3 Ch	*2008??*
004 5.8 Cd	Z LYR	032 9.1 Pt	975 10.8 Ch	994 6.6 Ch	968[11.6 Bl
008 5.5 Jo	185634	RY SGR	998 11.1 Ch	000 7.4 Kd	Z AQL
013 5.8 Pt	026 10.5 Pt	*191033*	001 12.5 Pt	001 6.8 Pt	*200006*
020 6.2 L	RT LYR	964 7.1 Bl	002 12.1 Rh	001 6.8 Ch	001 10.8 Pt
020 5.7 Pt	185737	968 7.0 Bl	032 13.0 Pt	008 7.3 Jo	033 13.0 Pt
021 6.1 Wa	975 9.8 Ch	969 7.1 Dr	R CYG	020 7.6 L	RS CYG
023 6.0 Gb	994 9.4 Ch	972 6.4 L	193449	028 8.4 Wa	200938
024 5.9 L	006 9.3 Ch	975 6.5 Ch	975 9.0 Ch	029 7.8 Jo	967 7.8 Ch
026 6.0 Pt	R AQL	975 7.0 Dr	994 9.7 Ch	032 8.2 Pt	971 7.4 Ch
027 5.9 Pt	190108	976 6.6 Bg	995 9 2 Jo	032 7.9 L	975 7.4 Ch
028 6.2 Wa	975 11.1 Ch	978 7.1 Dr	999 9.1 Jo	033 8.2 Jo	976 7.6 Ch
029 6.0 Jo	996 11.0 Ch	981 6.1 L	001 9.1 Pt	RR SGR	977 7.4 Ch
032 6.0 Pt	001 10.4 Pt	981 7.0 Dr	008 9.0 Jo	*194029*	978 7.4 Ch
032 5.7 L	026 9.2 Pt	982 6.8 Dr	021 9.9 Sg	968 12.8 Bl	981 7.2 L
032 6.4 Cb		994 7.0 Dr	023 10.5 Gb	000 12.0 Bl	984 7.2 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1927—Continued

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS CYG	Z DEL	V AQR	T CEP	RV CYG	R IND
200938	202817	204102	210868	213937	*222867*
994 7.2 Ch	001 9.0 Pt	001 8.1 Pt	971 9.5 Cb	001 6.9 Pt	946 9.7 Bl
995 7.2 Ch	033 9.8 Pt	036 8.4 Pt	981 8.7 L	037 6.6 Pt	963 10.5 Bl
995 7.1 Jo	SZ CYG	W AQR	984 9.1 Ch	RR PEG	967 11.1 Bl
998 7.2 Ch	202946	*204104*	994 8.7 Ch	214024	975 11.2 Bl
001 7.2 Ch	999 9.4 Pt	022 8.8 L	999 8.1 Jo	001 10.3 Pt	R LAC
001 7.2 Pt	001 9.6 Pt	U CAP	001 8.2 Pt	037 12.0 Pt	223841
006 7.3 Ch	002 9.6 Pt	*204215*	003 8.0 Jo	μ CEP	981 12.0 L
008 7.1 Jo	013 9.2 Pt	968[11.5 Bl	008 7.5 Jo	214058	001 10.4 Pt
021 7.2 Sg	020 9.5 Pt	T AQR	024 7.2 L	912 4.1 H	024 9.0 L
022 7.1 L	021 9.5 Pt	*204405*	029 7.5 Jo	913 4.1 H	038 9.5 Pt
029 7.0 Jo	022 9.5 Pt	975 7.2 Ch	033 7.4 Jo	914 4.1 H	RW PEG
033 7.2 Jo	024 8.8 Pt	001 7.6 Pt	037 7.4 Pt	R GRU	225914
033 7.3 Pt	026 9.1 Pt	001 7.2 Ch	RR AQR	*214247*	001 11.8 Bf
044 7.0 Jo	027 9.1 Pt	036 9.5 Pt	*210903*	968 12.0 Bl	038 9.2 Pt
R DEL	032 9.5 Pt	RZ CYG	001 11.6 Pt	U AQR	R PEG
201008	033 9.6 Pt	204846	037 13.1 Pt	*215717*	230110
978 9.5 Ch	036 8.8 Pt	001 13.1 Pt	X PEG	037 12.0 Pt	013 7.2 Pt
981 9.2 L	037 9.1 Pt	036 13.1 Pt	211614	RT PEG	038 7.4 Pt
001 10.5 Pt	038 8.8 Pt	S IND	001 10.5 Pt	215934	V CAS
031 11.8 L	039 9.0 Pt	*204954*	037 12.0 Pt	001 11.2 Pt	230759
033 11.6 Pt	040 9.2 Pt	968 12.3 Bl	T CAP	036 11.3 Pt	038 12.0 Pt
SX CYG	041 9.0 Pt	X DEL	*211615*	RZ PEG	W PEG
201130	042 8.8 Pt	205017	968 9.9 Bl	220133b	231425
001 13.6 Pt	044 8.9 Pt	001 11.7 Pt	S MIC	037 11.2 Pt	031 11.4 L
033 13.8 Pt	046 9.4 Pt	036 12.5 Pt	*212030*	T PEG	S PEG
RT SGR	ST CYG	R VUL	968 10.8 Bl	220412	231508
201139	202954	205923a	Y CAP	983 9.6 L	038 10.8 Pt
968 6.3 Bl	001 12.6 Pt	001 10.3 Pt	*212814*	024 9.5 L	Z AND
WX CYG	033 12.4 Pt	008 10.2 Jo	968 11.1 Bl	Y PEG	232848
201437b	V VUL	036 11.6 Pt	W CYG	220613	038 9.5 Pt
978 10.7 Ch	203226	V CAP	213244	001 11.7 Bf	ST AND
001 11.6 Pt	001 9.0 Pt	*210124*	912 6.0 Kd	001 12.0 Pt	233335
021 11.9 Sg	033 8.7 Pt	968 9.8 Bl	923 6.0 Kd	038 11.5 Pt	013 9.5 Pt
033 11.9 Pt	R MIC	X CAP	972 5.9 L	RS PEG	038 9.6 Pt
U CYG	*203429*	*210221*	981 6.6 L	220714	R AQR
201647	968[12.2 Bl	968[11.7 Bl	989 6.6 L	968 10.7 Bf	*233815*
994 7.8 Ch	S DEL	RS AQR	999 6.7 L	001 12.0 Bf	038 6.8 Pt
995 7.7 Jo	203816	*210504*	000 6.4 Kd	001 11.5 Pt	RR CAS
001 8.0 Pt	001 9.6 Pt	001 10.0 Pt	020 6.7 L	038 12.0 Pt	235053
008 8.0 Jo	036 9.2 Pt	022 9.9 L	030 6.6 L	X AQR	990[11.4 Bn
023 8.0 Gb	V CYG	037 11.0 Pt	S CEP	*221321*	004[11.7 Bn
029 7.9 Jo	203847	Z CAP	213678	001 14.0 Bf	R TUC
033 8.0 Jo	971 10.5 Ch	*210516*	001 9.4 Pt	S LAC	*235365*
033 8.2 Pt	994 10.0 Ch	037 13.2 Pt	037 9.1 Pt	222439	969[12.9 Sm
044 8.0 Jo	001 9.3 Pt	R EOU	RU CYG	981 12.8 L	Z PEG
U MIC	036 10.4 Pt	210812	213753	001 12.8 Pt	235525
202240	T DEL	001 10.6 Pt	001 8.3 Pt	031 12.7 L	038 10.6 Pt
968[13.0 Bl	204016	037 13.2 Pt	037 7.0 Pt	038 12.1 Pt	SV AND
	001 10.2 Pt				235939
	036 9.8 Pt				038 13.1 Pt

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D. Est.Obs.	J.D. Est.Obs.	Star J.D. Est.Obs.	J.D. Est.Obs.
005840 RX ANDROMEDAE—		060547 SS AURIGAE—	
5038.9 11.5 Pt		4972.2[11.0 Ch	4979.3[14.0 L
060547 SS AURIGAE—		4973.2[11.6 Ch	4980.1[15.1 Bf
4963.2[11.6 Ch	4967.1[13.3 Ch	4974.4[14.5 L	4984.3[13.3 L
4964.2[11.6 Ch	4969.2[11.6 Ch	4975.1[13.3 Ch	4989.3[14.0 L
4965.2[11.6 Ch	4970.1[11.6 Ch	4976.3[13.3 L	4990.4[14.0 L
4966.2[11.6 Ch	4971.1[11.6 Ch	4977.2[11.0 Ch	4991.6[12.4 Ch

RAPIDLY VARYING IRREGULAR VARIABLES—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
060547 SS AURIGAE—						
	4993.1	[15.1	Bf	5018.7	10.7	Sg
	4993.1	15.8	Bg	5020.7	11.5	Pt
	4994.6	[13.3	Ie	5021.6	11.1	Wa
	4996.1	15.3	Bf	5021.6	11.2	Ie
	4998.4	[14.0	L	5021.8	10.6	Sg
	5001.4	[14.0	Cl	5023.7	11.0	Sg
	5002.4	[14.0	L	5024.7	11.8	Sg
	5003.7	[12.4	Sg	5024.7	12.0	Pt
	5007.3	[12.4	L	5026.4	12.8	L
	5008.6	[12.4	Cl	5026.7	12.4	Pt
	5009.7	[12.4	Pt	5027.7	13.0	Pt
	5011.7	[12.6	Pt	5029.4	[13.0	L
	5016.3	10.8	L	5029.7	[11.6	Sg
	5017.7	10.7	Pt	5032.7	[12.6	Pt
	5018.6	10.7	Ie	5033.7	[12.6	Pt
074922 U GEMINORUM—						
	4963.2	[12.4	Ch	4992.1	13.9	Bf
	4964.2	[12.3	Ch	4993.7	[13.7	GC
	4966.2	[12.4	Ch	4994.6	[13.3	Ie
	4967.1	[13.3	Ch	4990.1	[11.7	Ch
	4969.2	[12.3	Ch	4996.1	14.2	Bf
	4970.2	[12.3	Ch	4997.1	[11.4	Ch
	4971.2	[12.3	Ch	4998.1	[11.4	Ch
	4972.2	[12.3	Ch	4999.7	[13.3	Pt
	4973.2	[12.3	Ch	5000.6	14.0	B
	4974.4	[13.7	L	5001.7	[13.3	Pt
	4976.2	[12.4	Ch	5002.7	[12.4	Pt
	4979.3	[13.3	L	5004.6	14.1	Cd
	4981.7	[13.7	GC	5006.1	[11.4	Ch
	4983.6	[13.3	GC	5008.6	[13.3	Cd
	4988.1	[13.7	Bf	5009.7	[10.3	Pt
	4990.6	[13.8	B	5011.6	[13.3	B
	4991.6	13.9	Cd	5016.4	[12.4	L
074922 U GEMINORUM—						
	5017.6	[12.0	B	5025.6	[13.5	B
	5018.6	[10.2	Wa	5026.4	[12.3	L
	5019.6	[10.2	Wa	5026.7	[11.7	Pt
	5020.7	[12.4	Pt	5027.7	[13.3	Pt
	5021.6	[12.4	Ie	5028.6	[12.4	Ie
	5022.5	[10.2	Wa	5029.4	[12.4	L
	5024.7	[13.3	Pt	5032.7	[11.7	Pt
213843 SS CYGNI—						
	4972.6	11.0	L	5027.7	11.7	Pt
	4973.6	10.7	L	5028.7	11.7	Wa
	4977.4	11.2	Ch	5028.6	11.7	Ie
	4978.4	10.9	Ch	5029.4	11.6	L
	4983.6	8.3	L	5030.4	11.4	L
	4984.4	8.4	Ch	5031.6	11.4	L
	4986.4	8.3	Kl	5031.6	11.7	Ie
	4987.4	8.3	Kl	5032.7	11.5	Pt
	4989.4	8.7	Kl	5032.6	11.1	L
	4989.6	8.8	L	5033.6	11.4	Ie
	4995.4	10.8	Kl	5033.7	11.6	Pt
	4999.6	11.8	L	5035.6	8.3	Cl
	4999.9	11.8	Pt	5036.9	9.1	Pt
	5001.4	11.8	Ch	5037.8	9.0	Pt
	5001.6	11.6	L	5038.9	9.2	Pt
	5001.9	11.7	Pt	5039.7	9.0	Gb
	5003.0	11.9	Rh	5039.8	9.5	Pt
	5004.7	11.8	Cd	5040.7	9.6	Pt
	5013.9	11.8	Pt	5040.6	9.5	Cl
	5020.6	11.6	L	5041.6	9.0	Ie
	5021.6	11.9	Ie	5041.7	10.5	Pt
	5021.8	11.8	Sg	5042.7	10.3	Pt
	5023.6	11.6	L	5044.7	11.7	Pt
	5023.7	11.7	Pt	5046.7	11.7	Pt
	5024.6	11.7	L	5046.7	11.6	Wa
	5026.7	11.7	Pt	5048.6	11.5	Cl

Total observations, 2614; Total variables, 370; Total observers, 39.

The following observers have contributed to the results here presented: Messrs. Allen, "Al"; Baldwin, "B"; Bappu, "Bf"; Benini, "Be"; Bhaskaran, "Bg"; Bouton, "B"; Brown, "Bn"; Chandler, "Cd"; Chandra, "Ch"; Cherrington, "Cb"; Clement, "Cl"; Dartayet, "Dr"; Ebert, "Eb"; Ensor, "En"; Fresa, "Fr"; Gaebler, "Gb"; Gomi, "Go"; Goodsell, "Gs"; Glaze, "Gz"; Hama, "H"; Houghton, "Ht"; Iedema, "Ie"; Johnstone, "Jn"; Jones, "Jo"; Kanda, "Kd"; Kohl, "Kh"; Kurtz, "Kz"; Lacchini, "L"; Logan, "Lg"; Miyajima, "Mj"; Peltier, "Pt"; Recht, "Rh"; Rowley, "Rw"; Skaggs, "Sg"; Smith, "Sm"; Watson, "Wa"; White, "Wb"; Yalden, "Ya"; and Georgetown College Observatory, "GC".

LEON CAMPBELL, Recording Secretary.

July 2, 1927.

METEOR NOTES.

By CHARLES P. OLIVIER.

Since the distribution of Bulletin No. 9 of the American Meteor Society, which contains the names and addresses of members, six more persons have joined and several applications are pending. The six new members are:

W. T. Coleman, County Engineer's Office, Spencer, W. Va.

H. W. English, Master in Chancery, Jacksonville, Morgan Co., Ill.
O. J. Hetzler, Canton, Mo.
W. C. Montgomery, Box 794, Pampa, Texas.
K. A. Shepherd, 703 Boulevard, Winston-Salem, N. C.
C. H. Smiley, Dept. of Math., Univ. of California, Berkeley, Calif.

While the interest in the work of the Society steadily grows, still there are states in which we have no members, and others where no member is observing. We therefore cordially invite persons in all parts of America, who would take an active part in the work, to join the Society, for there is more than enough work for everyone.

Clear skies in several parts of the country permitted extensive observations to be made during the latter part of June for meteors connected with Pons-Winnecke's comet. Already reports have been received from Michigan, Minnesota, Texas, and Virginia. These will be briefly reviewed in order. R. M. Dole, at East Lansing, Mich., reported skies of wonderful transparency. He observed on June 26, 27, 28, 29, 30, July 1 and 2. The total numbers seen on these nights (as given in a brief preliminary report) are respectively 38, 36, 39, 144, 86, 0, and 0. He states that most meteors were of magnitude 5 and 6, and hence were seen only because of the very transparent skies. There were also three fireballs, one equal to the quarter moon in brightness. He states that radiants in Corona were almost as active as those in or near Ursa Major. He obtained a shifting radiant in the former constellation, and near Zeta Ursae Majoris another just east of the 14 hour circle. It will be necessary to calculate the corresponding parabolic orbits before passing upon the connection of meteors from these radiants with Pons-Winnecke's comet.

Mr. Hugh D. Brown, at St. Paul, Minn., observed July 26 from 13 to 15 hours in a clear sky. He saw 8 meteors, but an inspection of his maps proves that none radiated from the general direction we would expect if they came from the comet.

From Ft. Worth, Texas, we have complete and very extensive reports from Mr. Sterling Bunch, one of our observers of many years' experience, and Mr. O. E. Monnig, who reports for the first time. Mr. Bunch worked on June 18, 23, 26, and 27; Mr. Monnig on June 23, 24, 26, and 30. On all nights but June 27 the sky was clear during observations. In order, the numbers of meteors recorded were 10, 26, 23, and 4 for Mr. Bunch; 16, 5, 20, and 9 for Mr. Monnig. A preliminary inspection of their map shows a small number of meteors that radiate from the expected region, but by no means a majority of those recorded. Other radiants are also clearly indicated.

At University, Va., C. P. Olivier observed regularly on June 27 and 28, and for short intervals on June 26 and 29. These last watches were just long enough to prove the absence of any large number of meteors. On all the nights the sky was mostly clear, and fairly faint meteors usually could be seen. On June 27, in about 4 hours of observing 29 meteors, and on June 28 in 70 minutes 6 meteors were observed. No radiant near the expected place was indicated with any certainty.

Just as this was about to be mailed a letter from Dr. W. J. Fisher of Harvard College Observatory arrived, in which he sends the following information sent him by Miss Harwood at the Maria Mitchell Observatory, Nantucket, Mass. On June 27, the observatory had an open night and between 9:30 and 11:30 the group saw "at least 25 meteors. Nearly all were of very short duration, faint,

and short trails." They radiated "decidedly from the tail of the Great Bear."

This confirms the opinion that the meteors which may have come from the comet's radiant were in general so faint that only those who were favored with very clear skies had a chance to see many of them. So far as it goes this tends to confirm also the very unusual observations reported from Japan in 1921 concerning these same meteors. It might be well to add, also, that Mr. Dole rejected from his totals 40 very faint meteors that were so faint he felt somewhat uncertain as to their actual presence. The writer also had to reject a few for the same cause.

While our June observations proved that no shower, worthy of the name, from Pons-Winnecke's comet was visible in America, we were rewarded by the best series of observations for the last week of June so far reported. Our knowledge of other radiants will be greatly increased when these observations have been definitely worked up. Also from our experience in America it is scarcely to be expected that a really fine shower was seen from any other part of the world.

McCormick Observatory, University of Virginia, July 16, 1927.

During the regular observational work on Monday night, June 27, 1927, incidentally watching Pons-Winnecke's comet, I noticed four meteors all of the same character, namely, very red in color, about fourth magnitude, very rapid in motion, radiating from a point about fifteen degrees from the comet in the direction half way between the head of Delphinus and Altair. The net time that I watched this part of the sky was about twenty minues. The previous night I saw one meteor with exactly the same characteristics and in the same region. They were all visible within fifteen degrees of the apparent radiant, with short trails about seven degrees in length, lasting one-third of a second.

JAN SCHILT.

Yale University Observatory.

While photographing Pons-Winnecke's comet on the night of July 1, between one and three a.m., Eastern Standard Time, I noticed six or seven meteors, of the kind described above by Dr. Schilt, radiating from a point somewhat to the west of the comet. The net time that I watched the sky was perhaps one hour.

F. WAGNER SCHLESINGER.

Yale University Observatory.

COMET NOTES.

By G. VAN BIESBROECK.

COMET 1927 *f* (GALE). Very little information is available about this comet, the sixth one announced since the beginning of the year. The discovery was communicated as follows by the Melbourne Observatory:

"June 7, $14^h\,30^m$ U.T. $\alpha = 21^h\,38^m\,0^s$, $\delta = -31^\circ\,38'$. Mag. 8. Motion unknown. Diameter 3 minutes. Diffuse slight condensation. Unconfirmed."

The object was confirmed three days later through an observation by Gonnessiat at Algiers:

"June 10, $3^h\,17^m$ U.T. $\alpha = 21^h\,53^m\,4^s$. $\delta = -31^\circ\,38'$. Mag. 10."

No further observations have become available. At discovery the object was too

far south for most northern observatories and its easterly motion of nearly 6 minutes a day made conditions even more difficult on later dates, since the angular separation from the sun decreases. Very likely southern observers will have secured the necessary measures for determining an approximate orbit.

The four comets announced previously this year have been kept under observation at various observatories. COMET 1926 *f* (COMAS SOLÁ) was recorded photographically at the Yerkes Observatory until May 31 as a 14^{M} object which was lost afterwards in the evening sky. As previously remarked it is quite possible that further observations may be obtained later in the season after the object emerges from the vicinity of the sun.

COMET 1927 *c* (PONS-WINNECKE). Considerable interest has been shown in the appearance of this comet which has now passed out of sight for northern observers. It surpassed the expectations as far as visibility is concerned. Except for the interruption at the time of the full moon, all through June one could easily follow it with the unaided eye. It reached a total brightness of fully 4^{M} at the time of its nearest approach. During the latter part of the month its rapid

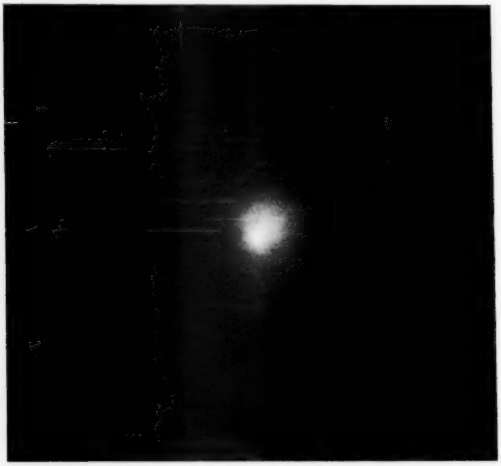


FIG. 1. Photograph of Pons-Winnecke Comet taken with 24-inch reflector of the Yerkes Observatory by Van Biesbroeck, July 27. Exposure 14^{m}.

motion across the constellations could be noticed after a short interval of time without the help of any instrument. It appeared then as a round hazy spot, about one degree in diameter, considerably brighter than the Andromeda nebula or the double cluster in Perseus. The nucleus however remained faint: in the telescope it appeared like a minute star of about 9th magnitude from which emanated, in the direction towards the sun, a narrow pencil of light gradually spreading in the shape of the calyx of a flower. This can be seen in Figure 1, although the central part has been overexposed in an effort to record the whole extent of the coma. The dissymetrical distribution of the light in the latter is quite marked but no trace of a tail extending beyond the coma could be detected at any time. In spite

of its considerable total brightness the diffuseness of the object made it very difficult to record the spectrum. At the 40-inch refractor O. Struve, using the Bruce spectrograph in connection with a short-focus camera, obtained only a very faint indication of an emission spectrum after guiding for three hours on the comet on June 26. The objective-prism used with the 6-inch UV Zeiss camera gave a somewhat brighter image. N. Bobrovnikoff and A. Pogo obtained the spectrum by that method on seven nights between June 19 and 28. Owing to the overlapping of the different parts of the image the details are very diffuse but the main condensations due to C IV, C+H and Cy IV could be well identified.

With the aid of four observations between Feb. 25 and June 10, B. Strömgren has computed the following elements (Cir. Copenhagen 154):

$$\left.\begin{aligned} T &= 1927\ \text{June}\ 21.064\ \text{U.T.} \\ \omega &= 170^\circ\ 22'\ 35\overset{''}{.}0 \\ \Omega &= 98\ \ 8\ 34.3 \\ i &= 18\ 56\ 25.9 \end{aligned}\right\} 1927.0$$

$$\text{Log. } e = 9.836076$$

$$\text{Log. } a = 0.519227 \quad (\mu = 590\overset{''}{.}428)$$

Comet 1927 *d* (Stearns) follows closely the ephemeris given on p. 351. The most recent observation here gives the residuals:

July 10 $+9^s$ and $-2'$

The brightness was estimated as of magnitude 12 on that night. The object appeared as a nearly round nebulosity about 1′ in diameter with a 13^M central nucleus. It will be possible to follow this comet for a long time yet with larger instruments.

Aside from periodic comet Schaumasse, the return of which is due this fall but under very unfavorable conditions, periodic comet Encke will be again under observation before the end of the year. The following search ephemeris computed by F. E. Seagrave will be helpful in finding the comet:

1927 Gr. 0^h U.T.		α h m s	δ ° ′ ″	Log. r	Log. Δ
Sept.	3	1 9 9	+18 12 37	0.39718	0.22333
	7	1 5 28	18 19 32	0.39112	0.20459
	11	1 1 4	18 23 2	0.38486	0.18592
	15	0 55 59	18 22 53	0.37838	0.16745
	19	0 50 9	18 18 21	0.37170	0.14937
	23	0 43 37	18 8 54	0.36480	0.13190
	27	0 36 22	17 54 10	0.35766	0.11524
Oct.	1	0 28 32	17 33 54	0.35030	0.09964
	5	0 20 9	17 7 37	0.34266	0.08527
	9	0 11 20	16 35 36	0.33474	0.07232
	13	0 2 14	15 58 0	0.32652	0.06101
	17	23 53 1	15 15 14	0.31800	0.05147
	21	23 43 50	14 27 59	0.30914	0.04374
	25	23 34 51	13 37 17	0.29994	0.03790
	29	23 26 14	12 44 23	0.29034	0.03379
Nov.	2	23 18 8	11 50 30	0.28036	0.03139
	6	23 10 40	10 56 54	0.26992	0.03037
	10	23 3 53	10 4 26	0.25898	0.03052
	14	22 57 54	9 14 18	0.24758	0.03180
	18	22 52 42	8 27 6	0.23560	0.03369
	22	22 48 17	+ 7 43 27	0.22300	0.03602

Comet 1927 *e* (Grigg-Skjellerup) is now on the decline. In the beginning of June it was easy to see even in a small telescope but it always stayed a very

diffuse object that was hard to measure. When last observed here (July 10) it was reduced to a round coma, some 40″ in diameter and its brightness had dropped to 15M. The ephemeris given on p. 351 required for that date the small correction: —0m5 and —1′ Although the object is very well situated in the constellation of Hercules it will soon be out of reach on account of its faintness.

Williams Bay, Wis., July 15, 1927.

GENERAL NOTES.

Professor Vincenzo Cerulli, the Italian astronomer, vice-president of the International Astronomical Union and of the Astronomische Gesellschaft, president of the Societa Astronomica Italiana, honorary professor of astronomy at R. University of Rome, died suddenly on May 30, at Merate (near Milano) during the inaugural ceremony of this new observatory. Professor Cerulli was born at Teramo (Abruzzi) on April 20, 1859.

Dr. A. C. D. Crommelin, astronomer at the Royal Observatory, Greenwich, has retired after thirty-six years' service. (*Science,* June 10, 1927.)

Professor Edward Skinner King, of the Harvard College Observatory, was granted the honorary degree of Doctor of Science by his alma mater, Hamilton College, at its recent commencement exercises. Professor King was graduated with Phi Beta Kappa honors in 1887, and has been connected with Harvard College Observatory since that time. In being presented for the degree he was characterized as "member of many societies of scholars, widely famed for pioneer work in the application of photography to the problems of astronomy, recognized master in science."

Professor A. A. Michelson, of the University of Chicago, has been elected an honorary member of the Russian Academy of Sciences. Professor Albert Einstein (Berlin), Mme. Curie (Paris), Professor W. Nernst (Berlin) and Professor M. G. Mittag-Leffler (Djursholm, Sweden) have also been elected honory members of the academy. (*Science,* June 10, 1927.)

American Astronomical Society, Thirty-eighth Meeting.—The following notes are taken from a circular of information issued June 15 by the Secretary, Joel Stebbins.

> On the invitation of the president and secretary, the thirty-eighth meeting of the Society will be held at the University of Wisconsin, Madison, from September 6 to 9, 1927. The American Mathematical Society and the Mathematical Association of America will also hold their meetings at the University during the same week, September 5 to 10.
>
> Madison is reached from several directions by the Chicago and Northwestern, the Chicago, Milwaukee, and St. Paul, and the Illinois Central railroads. Passengers from Omaha or Kansas City may make the best connection by the Milwaukee, but from Chicago the Northwestern and the Milwaukee are both good.
>
> For automobiles there are many good roads into Madison, those from Milwaukee and Chicago being paved for nearly the entire distance. The latest information about roads will be forwarded a week or so before the meeting to any members who request it.

The headquarters for the meeting will be in a group of fraternity houses attractively located on the shore of Lake Mendota. The chapters which have granted the use of their houses are those of Phi Delta Theta, Sigma Chi, and Sigma Alpha Epsilon. On arrival members should drive or take taxis to the Phi Delta Theta house, 620 North Lake Street.

Rates for members and friends will be $1.50 per day for room, and $2.50 for the three meals. Rooms will be available any time Tuesday, and dinner will be served at six-thirty that evening. Requests for reservations stating probable time of arrival should be sent to the secretary.

The mathematical societies will be located at Chadbourne Hall, a University dormitory about five minutes walk from our headquarters. Although no formal joint gathering is scheduled, there will be ample opportunity for the intermingling of members from the different societies.

Mail should be addressed in care of the Washburn Observatory, Madison, Wisconsin, which will be open to visitors throughout the week.

Professor E. B. Frost extends a cordial invitation to members of the Society and their friends to visit the Yerkes Observatory either on their way to Madison or on their return. He suggests that some might care to stay over at Williams Bay on Sunday and Monday, and a definite part of Monday evening, September 5, will be reserved to give opportunity to see through the 40-inch telescope.

Williams Bay may be reached direct from Chicago via the Northwestern, or from Walworth, Wisconsin, via the Milwaukee railroad. The motor route most highly recommended is Illinois No. 19, all cement, Chicago to Harvard and Walworth, thence to Yerkes on Wisconsin 36. Highway U. S. 12 from Elkhorn is usually the most attractive route from Williams Bay to Madison.

There will be no occasion for formal dress during the meeting. As it is only a step from any one of the houses to the lake, bathing suits will be much in evidence. There are several good golf courses about Madison, in particular those of the Maple Bluff and Black Hawk clubs, and arrangements will be made for the introduction of any members who care to play.

In addition to the usual sessions for the reading of papers, there will be a reception tendered by Professor and Mrs. Stebbins on Observatory Hill on Tuesday at 8:30 P.M. At 3:30 P.M. on Thursday there will be a drive around Lake Mendota. Tea will be served at Everett Lodge, Professor and Mrs. Comstock being hosts. On Friday there will be a boat ride at 2:00, and a special dinner at 6:30.

Observatory Proposed for Baldwin-Wallace College.—An attractive pamphlet setting forth the plans of a proposed observatory at Baldwin-Wallace College, Berea, Ohio, has been issued. The total cost of the enterprise is estimated to be $125,000. One hundred pledges have already been secured toward this project, and Professor O. L. Dustheimer hopes in the near future to realize the complete success of the undertaking.

The British National Almanac for 1929 has been received recently. Some new features of this volume are: 1. A new list of observatories, divided into two sections, the first containing those now active and the second those inactive or no longer existing. 2. A revised list of countries or regions using standard and non-standard time and the amount by which they differ from Greenwich. 3. Interpolation tables to be used in connection with the tabular matter of the Almanac when the values of quantities are desired for other than the times given. The tables give the coefficients for both Bessel's and Everett's formulae. 4. Values of the sun's coördinates for 1928 for the mean equinox of 1950. These changes and additions will be of value to many.

Isaac Newton Bicentenary in Italy.—In connection with the commemoration of the second centenary of the death of Sir Isaac Newton, held at the University of Rome on March 22, 1927, Professor Pio Emanuelli presented a paper entitled "Isaac Newton and his Principia."

Memorie della Società Astronomica Italiana.—In the year 1920 the *Memorie della Società degli Spettroscopisti Italiani* were discontinued, and a new Series entitled *Memorie della Società Astronomica Italiana* was commenced. This new series is now in the third volume. A table of contents shows among the contributors the names of many well-known Italian astronomers and a wide variety of subjects discussed.

The Fourth Pan-Pacific Science Congress.—It is announced by J. Voûte, in the *Bulletin of the Astronomical Institute of the Netherlands*, No. 123, that the Fourth Pan-Pacific Science Congress will be held in Java in 1929. It is intended that this congress will be opened on a date immediately following the total eclipse of the sun on May 9, so that the members of the eclipse parties may be present.

Eighty-five New Double Stars.—In the *Lick Observatory Bulletin*, No. 383, issued March 4, 1927, eighty-five new double stars are listed. These stars were discovered by Professor R. G. Aitken in carrying out the Lick Observatory Double Star Survey which originally included the study of the sky as far south as —22°. This list includes stars as far south as —18°, the remaining zone of the original plan to be examined by observers in the southern hemisphere. Of these eighty-five pairs more than half are less than one second apart, and twenty-five are separated by less than one-half a second.

Star Catalogues. — In *Scientia* for March, 1927, in an article entitled "A Notable Example of Collaboration in International Science" by G. A. Favaro, a section is given to a list of well known star catalogues beginning with the one by Hipparchus and ending with the Astrographic Catalogue. The expansion in the number of stars included is somewhat indicative of the expansion of astronomical thought as well. The list of catalogues there given is:

Hipparchus (Naked eye stars)	Epoch	134 B.C.	1,034 stars
Hevelius " " "		1660 A.D.	1,534
Bradley Modern		1775	3,222
Piazzi "		1800	7,648
Lalande "		1800	47,390
Argelander (North) "		1855	324,197
Gould and Schönfeld (South) Modern		1855	133,000
Astronomische Gesellschaft		1875	450,000
Astrographic		1900	2,000,000 in catalogue 50,000,000 on photographs

The last two are the results of the coöperative work of several observatories, the latter being the notable example referred to in the title of the paper.

Scientific American in a New Form.—The issue of the *Scientific American* for July, 1927, presents a new appearance. The size of the form has been reduced although there are more pages than usual. As this issue itself states, "We have decreased somewhat in over-all acreage, but we are a little bulkier to make up for it—more magazine as a matter of fact and in a little dif-

ferent shape." To us, the new form is an improvement over the old one. It is more convenient to handle, and the cover being much less colorful is nevertheless more attractive. The front cover of this particular issue presents what is apparently a recent photograph of Thomas Alva Edison. The issue contains many papers of interest, two especially so to amateur as well as professional astronomers. They are, "Is Mars Habitable?" by Henry Norris Russell, and "The Most Fascinating Spot on Earth" by D. Moreau Barringer, Jr. The latter is a study of what is known as the meteor crater in Arizona, with a description of investigations which are being planned to understand more completely its origin if possible.

Radio Time Signals:—Radio time signals have become so valuable that our readers will be interested in the following quotation from a letter by Captain Pollock, Superintendent of the U. S. Naval Observatory:

On 1 August, 1927, the United States Naval Observatory will begin sending Washington time signals at noon and 10 P.M., (E.S.T.) on wave-length 24.9 and 37.4 meters in addition to those now being sent on 74.7, 435, and 2,678 meters. No corrections will be calculated for the new signals, but they will serve for commercial purposes just as well as the other signals as they will have the same accuracy.

On Fundamentalism. — If there be some babblers who, though ignorant of all mathematics, take upon them to judge of these things, and dare to blame and cavil at my work, because of some passage of Scripture which they have wrested to their own purpose, I regard them not, and will not scruple to hold their judgment in contempt.—Copernicus: *De Revolutionibus (Dedication to the Pope). (Science News Letter,* October 30, 1926.)

Astronomy in Fiction. — It is doubtless true that at times fiction enters the domain of astronomy, and now in the new novel, "Red Damask" by Emanie Sachs, published by Harper and Brothers, astronomy enters the domain of fiction. One of the characters in this story escapes from the worries of household cares and the vexations of family interference by resorting to a small room on the roof and there observing variable stars. The apparently abrupt change in SS Cygni (p. 313) may have been due to bad "seeing" induced by the oil-stove which this observer lit on entering her observatory that evening! It is difficult to understand the sentence on page 314, "0.2 degrees magnitude in a few hours!" In fact it seems that the astronomy in this work of fiction is also fiction.

A Student's Impression of the Observatory by Day.— Probably the most cheerless looking place in the world is an observatory in the daytime: a clock ticks away the sidereal hours, the only living thing in a place that time has evidently forgot; gaunt telescopes stand mute on a dusty floor; a musty odor permeates the rooms; when you enter, the living world is left behind, you are alone in a place where time and place mean nothing, for time is measured in millions of years and space in billions of miles; where you mean nothing, the veriest, lonely, unimportant atom in a stupendous whirling universe filled with titanic struggling forces—.

The telescope is the astronomer's magic wand with which we escape from this earthly pale and wander in space, free and alone, listening to the music of the celestial spheres. With a telescope you journey from the mountains of the moon

to the sun, from the sun to a stroll with Orion and the Dogs, then to the Pleiades, and, after a rest in Casseopia's chair, back to the cold matter of fact chunk of elements that we call earth.

Written by J. J. SOMERVILLE, a student at Lehigh University.

Calendar Reform in Turkey.—The National Assembly of Angora has decided to adopt the Gregorian Calendar for the Turkish Empire beginning with January 1, 1927. According to the old Turkish reckoning, which still is permitted in unofficial life, the present year is considered as the year 1325, therefore in adopting the new style 602 years are dropped out. At the same time the twenty-four hour day was introduced into official life. (*Das Weltall,* January, 1927.)

Large Telescope for Royal Observatory, Edinburgh: Our readers will be pleased to learn that a large reflector is to be erected at the Royal Observatory, Edinburgh. The telescope which is to be of the Cassegrain type, will probably have an aperture of 36 inches and certainly not less than 30 inches. A spectrograph similar to that used in conjunction with the 72-inch reflector at Victoria, and arranged for taking spectra with 1, 2, or 2 prisms, will be attached to the reflector. It is intended, in the first place, to use this powerful apparatus for the photometric investigations of stellar spectra—a field of research which has already been carried on under Prof. Sampson's direction with marked success by means of less powerful instruments. (*The Observatory,* March, 1927.)

The Centenary of the Birth of Donati (1826-1926).—On the 25th of November, 1926, upon the occasion of the distribution of prizes to the students in the Seminary and College of St. Catherine, where Donati received his education up to the time of his entrance to the university, the life of this noted astronomer was commemorated. The authorities of the city, Cardinal Maffi, and a number of distinguished citizens assisted in the ceremonies. On December 16, through the aid of a committee of citizens of Pisa, a bronze tablet was placed on the house where Donati was born, and on the same day the 100th anniversary of his birth was celebrated. On this occasion Professor Marco Salvadori of the College of St. Catherine, reviewed his life, so short and so well filled. (*Ciel et Terre,* February, 1927.)

A Model for Inter-nebular Space.—In commenting upon the paper by Dr. Hubble in the *Astrophysical Journal* for December (1926), Professor J. H. Jeans in *Nature* for February 26, 1927, suggests a method for visualizing the stupendous reaches of space and the enormous number of nebulae necessary to be accounted for according to recent investigations. Based upon the fact that the faintest nebulae observed on photographic plates of the 100-inch reflector are of the eighteenth magnitude and assuming that all nebulae are approximately alike as to size and brightness, the apparent differences being attributable to distance. the conclusion is reached that the most distant nebulae observed are of the order of 140,000,000 light years from us, and that the total number within this range is in the neighborhood of 2,000,000, separated from each other on the average by about 1,800,000 light years.

Professor Jeans says, "To construct a model, take 20 tons of walnuts and space them at about 25 yards apart, thus filling a sphere of about a mile radius. This sphere is the range of vision of the 100-inch telescope; each walnut is a

nebula containing matter enough for the creation of perhaps a thousand million suns like ours; each atom in each walnut is a solar system with a diameter equal to that of the earth's orbit."

Such a universe, or collection of universes, requires an expansion of thought and comprehension beyond anything hitherto dreamed of, and one might be suspicious of it as a mere theory without observational data, but Professor Jeans says further, "Dr. Hubble paints a most fascinating picture of the system formed by the great nebulae, and frames it in such convincing observational evidence that it would be difficult to reject it."

Errata.—An obvious but unfortunate typographical error occurs on page 388 of this issue in the paper by John F. Sullivan. In line 13 instead of *Georgian* read *Gregorian*. Ed.

On p. 336 of the June-July number, lines 4, 5 and 9 from bottom, for *Saturn* read *Jupiter*.

BOOK REVIEWS.

Readable Relativity, by Clement V. Durell. vi plus 146 pp. G. Bell & Sons, Ltd., Portugal St., London. 1s. 6d net.

So many books on Relativity have been written for the "general reader" and they have been so much alike that the physicists are inclined to smile when a new one appears. Several of these books overshoot their mark at the same points and share the same sins of omission. However, this book by Durell is different. While it is written professedly for the "average person," it departs from the beaten track and amply justifies its existence. All of the customary, fantastic illustrations, intended merely to startle the reader, are omitted. The author sets out with one avowed purpose, namely, *precision* of ideas, and steadfastly pursues this goal. Assuming a meager acquaintance with the principles of Newtonian mechanics and a knowledge of elementary algebra, he develops or states in mathematical form the concepts and principles peculiar to the subject, and supplies numerical examples worked out to the minutest detail. These numerical examples, which run throughout the book, are characterized by exceptional clearness of expression. Any reader who has the patience to follow these through will get a firm grasp of the fundamental differences between the relativist's view of the world and that of Newton. And in this very precise statement of the ideas of Einstein and the lucid distinctions between Einstein's assumptions and those of Newton, the author has made a real contribution to the literature of relativity.

Early in the book the reader is prepared for such things as contraction-ratios, four-dimensional space-time, and curved space by a clever illustration which the author takes from Professor Garnett's article in the *Mathematical Gazette* of May, 1918. The whole of Chapter II is devoted to "Alice through the Looking-Glass." Alice is not treated as a girl in a dream. She is regarded as the image in a convex looking-glass of a pseudo-Alice (called Alicia) who moves back and forth in our own world in front of the looking-glass. Several numerical examples are given to show what happens to Alice and the measuring stick that she carries, when Alicia executes various motions and gestures in front of the convex mirror. It is made evident that the geometry of Alice is not the same as the geometry of Alicia. And the question is raised, Can Nature deceive us?

After this chapter the concept of absolute motion is presented and the Michelson-Morley experiment is introduced by means of the conventional swimmer illustration. The impossibility of synchronizing the clocks of observers whose axes of reference move relatively at constant speed leads up to the necessity for a union of space and time. Following Professor Whitehead, the name of this fusion of space and time is called the "separation" of two events and the reader is led by careful logic to see that separation is an *invariant* and therefore a true property of two events concerning which all observers will agree. Emphasis is laid on the fact that separation is a physical reality. Relativity is shown to be an unfortunate name for the principle because Einstein has in fact isolated external reality. Mathematical proof is given for the fact that the separation is equal to the "proper time" between two events in the life of a body, *i.e.* the time as measured by a clock carried along with the body. And the Geodesic Law of motion follows: that if a body moves freely the space-time path followed between any two events is such as to make the separation and the proper time a maximum.

In the light of the principle of Restricted Relativity such concepts as mass, velocity, momentum, etc., are discussed and Fresnel's *convection coefficient* is developed mathematically.

The General Theory of Relativity is inadequately presented at the end of the book. The Principl of Equivalence is set down following the usual illustration of a man's experiences in an air-tight, glass box falling freely. The author then adds the regulation case of A's life on a rotating disc and points out the reversed "gravitational" field and the non-Euclidean character of his geometry.

In the reviewer's opinion this book shows two defects, characteristic of most of the books on relativity: the almost complete omission of references to original sources; and the wholly inadequate discussion of experimental tests of general relativity. Only ten pages are devoted to the experimental work on this important matter. But one page is given to the research on the shift of spectral lines toward the red. St. John's work at Mount Wilson, for example, on the spectra of different levels of the sun is not mentioned. Miller's recent work on the Michelson-Morley experiment is merely alluded to in a foot note. And the recent similar experiment in Millikan's laboratory at Pasadena is not mentioned.

J. W. Hornbeck.

New Dynamical Wave-Theory of the Tides, by Capt. T. J. J. See, U. S. N.

In a pamphlet published by the U. S. Hydrographic Office, Dr. See has reviewed and discussed many of the investigations relating to the theory of the tides. He accepts the general explanation of a vast wave travelling round the world, after having been started by the attraction of the sun and moon, with a period governed by the periods of the attractive forces, the initial motion having practically disappeared, from the resistances encountered. This view is in opposition to the principle of attributing tides in various parts of the world to the action of local forces mainly,—the same forces as before, but controlled by local conditions.

In the general tidal theory, variations in the height of the wave will occur, as it encounters the great continents, in its path. And the irregularities of coast lines will introduce other variations in height.

In discussing the delayed arrival of the crest of the tide wave, which follows the epochs of the maxima of the attractive forces by 34 hours, he notes that the

ratio of this interval to the 24 hour day is the same as the ratio of the period of 427 days in the variation of latitude to the Eulerian period of 305 days. The Eulerian period is that corresponding in theory to a perfectly rigid sphere rotating as does the earth; and such a period in observations of latitude was long sought for by mathematicians and astronomers. Eventually Dr. S. C. Chandler, discarding any preconceived length for the period of latitude variation, searched all existing records of long continued observations for any real period, and thus established the so-called fourteen month term. The best value, among several successive approximations, was that of 429 days. His latest value published in 1894, and based upon a limited series of observations, was 424 days. From the extensive accumulation of latitude observations at the international zenith telescope stations, during the past thirty years, and thus following the date of Chandler's last computations, the period of 435 days is found. This reference to one of the most interesting campaigns in the history of astronomy is made to recall the facts in the case. The explanation of the non-existence of the Eulerian period is that the earth is not perfectly rigid, but is about as elastic as a solid sphere of steel.

The virtual identity of the two ratios described above is clear enough. But the inference that the tide wave with its short period—reckoned in hours—produces the variation of latitude with its long period—reckoned in months—does not as clearly follow.

The possibility of the existence of a diurnal term in the variation of latitude has often been discussed by astronomers. The investigation of such an effect is so much involved with the errors of atmospheric refraction, and their variation, and with possible errors in the adopted nutation, employed in the computation of the declinations of the stars, that definite results are difficult to reach. A diurnal period in the corrections for atmospheric refraction has been established by observations at Pulkova, Mount Hamilton and San Luis. As a further complication, the existence of a horizontal component in the refraction at the zenith has been sometimes considered as possibly a factor. The effects of atmospheric refraction upon results must be completely eliminated, to reach a definite conclusion in respect to diurnal latitude variation.

Observations with a prime vertical transit at the Turin Observatory, in 1920, apparently gave a diurnal cosine term in latitude with a coefficient of 0".07. The extensive series of prime vertical observations of α *Lyrae* at the U. S. Naval Observatory, extending through a period of nineteen years, exhibit a much larger variation, approximately half a second of arc, between day and night, due to some cause not yet definitely established. The zenith telescope results at the latitude stations are confined to a relatively small part of the 24 hour day, and do not contribute data for a full diurnal term. Meridian observations of a fundamental character may eventually solve this problem, but suitable observations hardly exist in sufficient quantity at the present time.

The fundamental work at the Lick Observatory, of the epoch 1906, gave a possible diurnal term in the latitude, with a coefficient of 0".06. This result is found in *L. O. Publications*, Vol. XV, page 57. A special series, epoch 1916, gave a periodic term with coefficient 0".18. This result is found in the same volume, page 134. Observations at large and various zenith distances are required for the best method of solving this question, and the meridian circle is the best instrument for the purpose.

With some assumptions, the daily effect of the tide wave upon the position

of the pole of figure of the earth has been computed by Dr. See to be close to 0".16. This numerical result is the same as that of the coefficient of the fourteen month term in the variation of latitude. The investigations of Dr. Chandler generally gave a result close to this figure, and the zenith telescope observations of the past thirty years give this same figure. Whether there is any dependence of the latitude variation—period of fourteen months—upon the tidal wave—retardation 34 hours—in conformity with this coincidence in numerical values of the two effects remains open to doubt. A real correlation of the daily tide wave and a diurnal term in latitude variation—if there is such a term—would be more convincing. R. H. T.

Sternhaufen, by P. ten Bruggencate (Julius Springer, Berlin; price 16.50 marks).

This little volume of 158 pages gives a good resumé of our present knowledge of star clusters both of the globular and of the more open types. After an introductory chapter the author deals with the methods of determining the distances of clusters, the density laws in globular clusters, the problem of ellipsoidal clusters, theoretical investigations of the structure of clusters, and, finally, the place of star clusters in an empirical cosmogony. The one investigation of consequence which seems to be omitted is that of V. M. Slipher on the radial velocities of globular clusters. The book is timely as so much attention is being paid to star clusters at present and the many references make it a source-book as well. It is recommended to all who read German as a book worth having. E. A.F.

Eclipse in England.—Just as this form is going to press we received a short account of the total eclipse of the sun of June 29 from Pres. D. W. Morehouse who had the good fortune to see it from Southport. We quote:

"But the clouds! I had been in England three days and had not seen the sun more than ten minutes altogether. . . . . .

"Great crowds were gathered at every available observing point along the path. Special trains were run from all large centers of population. No eclipse could have been more thoroughly advertised. Huge bill boards showing the eclipsed sun with its fiery chromosphere and beautiful expanding corona were seen at every corner and crossroads. All the way stations were copiously placarded with announcements of the coming spectacle. The telegraph company used special eclipse stamps. England was proud of her opportunity and intended to make the most of it both in a scientific and commercial way. . . . . .

"The sun appeared above a cloud and we watched eagerly for the first contact. Then followed an hour of great anxiety as the rising sun fought with the gathering clouds. Ten minutes before totality the crescent sun was a mere blotch with little shape even through good binoculars, but it was rapidly approaching a clear spot. Those indescribable moments just before totality were now upon us. The shadow was coming. It first darkened the clouds in the southwest and then descended with truly terrifying grandeur giving the impression of a terrific storm. The shoreline between land and sea seemed to disappear and with incomprehensible suddenness the light went out.

"The shadow bands and Bailey's Beads did not appear nor could the flash spectrum be seen, at least not with small instruments. The chromosphere and prominences were wonderful. A distinct golden ring encircling the inky black sphere of the moon could be seen. Its beauty was heightened by the many large and brilliant prominences. An unusually large and bright arc of the chromosphere with a prominence at least 50,000 miles high appeared at the upper right of the sun, at about the position of one o'clock on the clock dial. At least a dozen more prominences could be distinctly seen.

"The inner corona was beautiful but nothing of the long streamers or petal-like extensions at the equator or the auroral plumes at the poles could be seen."